MAOA BREAK-OUT SESSION #2
TUMORS AND SEGMENTAL BONE LOSS
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19. Pediatric Chondrosarcoma: Analysis of the NCI Seer Program Data

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PURPOSE: Chondrosarcoma is relatively uncommon in children. We reviewed cases accessioned by the National Cancer Institute (NCI) Surveillance, Epidemiology, and End Results (SEER) program 1973-2001 and examined patient characteristics and outcomes compared with older age groups.

PATIENTS/METHODS: Of 1,797 cases of primary chondrosarcoma identified in the SEER registries, 108 cases (6.0%) were diagnosed at age <20 years. 12.6% of pediatric cases showed distant metastasis at diagnosis and 11.3% had received radiotherapy. Most pediatric cases involved the extremities (n=64; 61.0%); however, a significant proportion (n=17; 16.2%) involved head and neck sites. Five cases (4.8%) involved the spine and three involved the meninges or CNS (2.7%).

RESULTS/DISCUSSION: Overall survival for pediatric chondrosarcoma was 82.7% +/-3.8% at five years. This compared favorably with overall survival for cases diagnosed at ages 20-39 (85.9%, n=476), ages 40-59 years (81.3%, n=605), and ages 60-79 (53.1%, n=507). The male to female ratio significantly decreased with increasing age. Ratios ranged from 1.8 for cases <20 years at diagnosis to 1.1 for cases diagnosed at 40-59 years of age. Primary tumors were more likely skeletal in the pediatric population, occurring 97%, 96%, 92%, and 87% in cases diagnosed at <20, 20-39, 40-59, and 60-79 years of age, respectively. Skull and lower extremity primary tumors were significantly more prevalent under age 20 (16.2% and 49%, respectively), compared with older age groups (2.1% to 9.6%) and (28% to 37%).

CONCLUSION: These data confirm a similar prognosis for pediatric chondrosarcoma compared with adult patients. Male sex and presentation in the skeleton, specifically the skull and lower extremity, appears to be more common in childhood.

20. Endoprosthesis for Salvage for Failed Fixation of Long Bone Metastases

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Standard fixation technique may not be adequate to provide durable stabilization of long bones affected by metastasis. The purpose of this study was to assess the functional, oncologic, and reconstruction outcome after salvage of failed fixation with an endoprosthesis.

A review of 1,050 consecutive patients who underwent surgery for long-bone metastases yielded 42 patients for whom a segmental endoprosthesis was implanted to salvage failed fixation. Seven different diagnoses with greater than half of the patients (n=23) diagnosed with renal cell carcinoma. Of the six sites of failure, the most common was the proximal femur (n=17). The method of fixation that failed included 20 rigid intramedullary nails, 5 flexible nails, 4 plate fixation, and 3 hip screw/side plate. The mode of failure included local disease progression with loss of stabilization (n=26), fracture nonunion (n=7), and 5 with persistent pain despite stabilization and radiation. Median time to failure was 12 months (1–87 months). Modular endoprostheses were cemented in all patients.

Of the 42 patients, 41 retained an endoprosthesis at last follow-up or death (median 11 months). Local pain was controlled in all patients. All patients with lower extremity reconstructions were ambulatory with immediate weight bearing after surgery. Upper extremity patients regained full elbow, wrist, and hand function. Local tumor recurrence in the bone developed in two patients. Only one patient needed a revision procedure (aseptic loosening at 36 months). The median MSTS was 68%.

Endoprosthesis reconstruction is an effective, durable salvage of failed fixation in patients with metastatic disease yielding predictable restoration and maintenance of function and pain control with low associated morbidity.

21. Effect of DMSO on Chondrosarcoma Cells, an In Vitro Study

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The aim of this study was to evaluate the effect Dimethyl sulfoxide (DMSO) has on the culture of several cellular lines of chondrosarcoma. Chondrosarcoma primary cultured cell (CSPG) and a first passage human chondrosarcoma cell line (JJ) were used. Controls were done using a freshly established human osteochondroma cell line, a mesenchymal fibroblast cell line, and four different cell lines: CALU-3: epithelia, Human lung adenocarcinoma; MDCK: epithelia, Canine kidney; VERO: epithelia, monkey kidney; HEK: epithelia, human embryonic kidney. Rat chondrosarcoma cell lines (LTO and SRC JWS) were also evaluated, and freshly established rat chondrocyte were used as controls. Cellular death was evaluated using the Trypan blue method, as described. Statistical analysis was done using Chi Square method. Statistically significant differences ($p<0.0001$) were found between chondrosarcoma cell lines and controls using different concentrations and different exposure times. Cellular death rates were of 100% in chondrosarcoma cells in concentrations higher than 10% DMSO, and in periods higher than six hours. The cellular death rate in controls was not higher than 23% in any of the cell lines. Most of them were below 10% of cellular death rate even after being under DMSO concentrations of up to 40% for 48 hours. Chondrosarcomas do not generally respond to chemotherapy or radiotherapy, therefore, metastatic disease is rarely amenable to curative treatment. DMSO has been used for multiple clinical and experimental purposes, most commonly as solvent in biological studies and as a vehicle for drug therapy. This is the first report on the effect of DMSO on chondrosarcoma cells. Future studies, evaluating cell activity during DMSO treatment, such as RNA micro arrays and animal models, should provide some light on the mechanisms involved in the exclusive deleterious effect of DMSO on malignant cartilage cells. DMSO has a definitive effect on chondrosarcoma cell lines, on the suppression of further growth and induction of cellular death, and it could be a novel alternative for chemotherapy either as a primary treatment or as co-adjuvant.

22. Plate Fixation of Pathological and Impending Humerus Fractures

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Historically, pathological and impending long bone fractures from metastatic disease have been treated with intramedullary nailing. This technique has gained acceptance because of low complication rates and for providing definitive fixation of an entire long bone with one procedure. However, intramedullary nailing of pathological humerus fractures has been associated with several complications including shoulder pain, failure of fixation, and nonunion.

Eleven consecutive patients with metastatic disease and impending or pathological fractures of the humerus were treated with plate fixation. Patients were treated with a Synthes blade plate device, Synthes proximal humeral plate, or Synthes 4.5 mm locking compression plate. In patients with significant bone loss, supplemental cementation was used. Follow-up ranged from 1-26 months. In long-term survivors (greater than six weeks), all fractures went on to successful union with no fixation failures. No same bone distant or proximal metastases were observed in the plated humerus. No revision surgeries were required. No shoulder impingement was observed in this series. In addition, patients were allowed weight-bearing through the operative upper extremity if necessary due to lower extremity disease.

In conclusion, plating of pathological or impending diaphyseal humerus fractures was shown in this series to be a viable alternative to intramedullary nailing, avoiding the complications of shoulder pain. There were no failures of fixation or nonunions in this series.

23. Results of Total Hip and Total Knee Arthroplasty in Patients with Synovial Chondromatosis

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INTRODUCTION: Synovial chondromatosis (SC) is a rare benign condition that involves the synovial lining of joints, bursae, or tendon sheaths whereby the synovium undergoes metaplasia and ultimately forms cartilaginous loose bodies. The multiple intra-articular osteochondral loose bodies lead to degeneration of the articular cartilage and end-stage arthritis. This is the first report, to our knowledge, on the outcome of total hip and total knee arthroplasty in patients with SC.

METHODS: All patients with diagnosis of SC undergoing THA and TKA between 1970 to 2003 were identified using our institution's computerized database. SC had been confirmed by pathology in a total of 13 patients, including 5 patients who had a total knee arthroplasty (mean age of 64 years) and 8 patients who had a total hip arthroplasty (mean age of 59 years). All 13 patients returned for follow-up examination and radiographs at a mean of 9 years after surgery (range, 14 months to 35 years). A detailed review of the each patient's clinical records and radiographs was conducted.

RESULTS: The average interval from the time of diagnosis of SC to joint replacement surgery was 5.7 years (range, 0-13 years). Pain and functional status improved significantly in all patients based on the Knee Society and Harris Hip Scores. There were no infections in either group. Knee range of motion improved from an average of 63° preoperatively to 97° postoperatively. Three knees required manipulation under anesthesia for postoperative stiffness. Synovial chondromatosis recurred in two knees (40%) and one hip (12.5%). There was one revision in the entire series for acetabular loosening.

DISCUSSION: Synovial chondromatosis, although rare, can be an aggressive condition leading to destruction of the articular cartilage of large joints. Joint arthroplasty is a valuable treatment option for these patients with predictable improvement in pain and function. However, range of motion after total knee arthroplasty is less than expected and patients remain at risk for disease recurrence.

24. Onlay Cortical Strut Allografts: A Solution for Difficult Fracture Healing Problems

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Comminution, bone loss, poor quality bone, and delays in fracture healing of the femur and humerus present problems for orthopedic surgeons. Techniques of onlay femoral strut allografts used in revision hip surgery can be used to treat nonunions and difficult acute fractures.

A prospective consecutive series of 31 patients treated by a single surgeon with at least 24 months follow-up (average follow-up 46 months) is reviewed. The fracture categories include 8 acute fracture cases, 6 delay in healing, and 17 nonunions. There were 26 femoral fractures and 5 humeral fractures. The majority of the femoral nonunions already had two intervention failures using routine fracture management techniques. The fracture fixation of either predominantly intramedullary rodding or plating was supplemented with onlay femoral allograft struts cerclaged with cable fixation. Supplemental autogenous iliac crest graft and/or demineralized bone was used in the majority of cases. The deeply frozen not freeze dried femoral strut allografts were obtained from an accredited American Association of Tissue Bank.

All 31 fractures healed without need for further operation or stimulation devices. There were no wound healing problems, infections, or neurovascular complications. There were no strut fractures or cable breakage. The average time to radiographic incorporation of the allograft strut to the host femur averaged just over one year. No significant reabsorption of the allograft strut was identified. The onlay strut facilitated early full weight-bearing and function without failure of the fixation well before any radiographic evidence of healing. The onlay graft technique increased the operative time by 60 minutes and the estimated additional blood loss was about one unit.

The technique of onlay femoral strut allografts used in revision total joints have added to the options for fracture surgeons. Caveats in technique of onlay strut grafting insures a reduced complication rate. The soft tissue around the femur and humerus allows for more extensive exposure and the safe application of these bulky femoral struts in selected difficult-to-heal fractures of the humerus and femur.

25. Iliac Crest Aspiration and Injection in the Treatment of Delayed Unions and Nonunions

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INTRODUCTION: The treatment of nonunions often requires bone graft augmentation. Percutaneous injection of autologous bone marrow harvested from the iliac crest has been advocated as a minimally invasive method for stimulating bone healing in delayed unions and nonunions. However, few studies have looked at the effectiveness of this procedure.

MATERIALS AND METHODS: Twenty-three patients (16 female, 7 male, median age 45, range 16-79) underwent iliac crest aspiration and injection at our institution between the years 1995 and 2000. A retrospective review of these patients' charts and radiographs was performed, evaluating duration of nonunion, mechanical stabilization, perioperative complications, surgical technique (including the use of centrifugation for preparation of the autograft), and time to union.

RESULTS: Fifteen of 23 patients (65%) treated with aspiration and injection did not heal. Seven patients (30%) went on to bony union after their first procedure (average time to union four months). One patient healed a femoral nonunion after the second procedure. Twenty of 28 (71%) total procedures performed in this population failed (8/10 tibia, 9/11 femurs, 2/5 humeri, 1/1 forearm, 0/1 radial neck). Four of five patients receiving multiple injections (>1) had persistent nonunion. Centrifugation was utilized in all procedures, and injections were performed under fluoroscopic guidance. The average marrow injected was 27 cc. There were no complications with the procedure itself.

CONCLUSION: Iliac crest aspiration and injection alone is an ineffective procedure for the stimulation of bone healing in the setting of nonunion. Further studies are needed to delineate the role of this procedure in nonunion management, as well as the balance between stabilization and biologic factors in bone healing.

26. ♦Segmental Bone Defects Treated with Recombinant Human Bone Morphogenetic Protein-2

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(Taylor A. Konkin, M.D., Fort Wayne, IN presented)

INTRODUCTION: Recombinant human bone morphogenetic proteins have been used successfully in lumbar fusion and acute open tibia fractures. The purpose of this study was to evaluate the union potential of recombinant human bone morphogenetic protein-2 (rhBMP-2) implanted on an absorbable collagen sponge (ACS) in human segmental bone defects.

METHODS: We performed a retrospective analysis using rhBMP-2/ACS with bone graft substitutes in treating 19 segmental bone defects. Ten defects were 100% circumferential, while 9 were partial. Defect length averaged 4.75 cm, ranging from 1.5 to 8.0 cm. Open fractures occurred in 14 patients. Failure was determined as need for further surgical intervention or nonunion. A fracture was noted as healed by clinical use without pain and radiographic consolidation.

RESULTS: Bony union occurred in 16 of 19 bone defects (union rate of 84%). Average time to union was 8.4 months (range 3.5 to 13.5 months). Failure was noted in three patients. Two of these patients were treated early on in the study with tricalcium sulphate in association with rhBMP-2/ACS and had premature resorption of the graft. The third failed patient had fixation failure at six weeks due to non-compliance. No infections were reported. No clinical reactions from the rhBMP-2 were reported.

CONCLUSION AND SIGNIFICANCE: rhBMP-2 has the capability to heal critically sized post-traumatic bone defects in a variety of patients, with a success rate of 84% in our study. This can be done without the morbidity associated with autograft or many of the complications of other treatment. Treatment can also occur in a timely fashion given the severity of injury in some cases.

27. A Novel Technique for Intercalary Allograft Fixation in the Proximal Tibia

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(S. Trent Guthrie, M.D., Detroit, MI presented)

The use of proximal tibia intercalary allografts is a biologically stable joint preserving option for limb sparing surgery following resection of high grade extremity sarcomas. However, problems with fixation, nonunion, and fractures have limited their use and wide acceptance. Attention to reconstruction with minimization of screws and the use of a 95° fixed angle blade plate can provide for stable fixation, and in most instances obviate the need for additional live bone enhancement. Intercalary allograft reconstructions were performed in two adolescents with high grade tibial sarcomas. The cutting chisel and blade plate were placed along the anteromedial tibia prior tibial osteotomy. The blade plate was angled toward the proximal posterolateral corner of the tibia, and it was contoured along the anteromedial tibia and allograft prior to placement. After plate insertion and allograft reduction, we utilized an AO articulating tensioning device. The allograft-host bone interfaces were fully compressed with the tensioning device. The blade plate was fixed to the intercalary allograft with judicious screw placement. The patient's patellar tendon was interwoven and fixed to the intercalary allograft patellar tendon with a spiked washer and 4.5 mm cancellous screw. A medial gastrocnemius flap and split thickness skin grafts were used in final wound closure. Successful outcomes were determined by union, return to normal function, and retention of graft. The mean duration of follow-up was 21 months. There were no fractures, nonunions, or tumor recurrences. One patient denuded his insensate split thickness skin graft site and developed a late infection, which resolved with aggressive management. The use of a well established, inexpensive fixed angle device for the fixation of an intercalary allograft of the proximal tibia is a novel and innovative option in limb sparing surgery. This device allows for compression of both host-allograft junctions, while also functioning as a spanning device for stress shielding and fracture prevention. This technique combined with judicious use of screw placement can likely obviate the need for additional live bone enhancement.

28. Osteoporosis in Hospitalized Orthopedic Trauma Patients: An Opportunity to Intervene?

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PURPOSE: Trauma patients tend to carry many of the risk factors for osteoporosis: substance abuse, psychotropic drugs, inactivity, etc. Our goal is to identify the characteristics of osteoporosis on the inpatient orthopedic trauma service at a busy trauma center, and provide a simple algorithm to initiate treatment for this disease.

METHODS: After IRB approval, all patients treated for acute injury by a fellowship-trained orthopedic trauma surgeon at our trauma center were identified from a prospectively designed orthopedic database. Two-hundred and seventy-five consecutive adult patients with >600 skeletal injuries were evaluated and treated over a six-month period after establishment of an "osteoporosis protocol." This protocol included: a validated bone density test (Achilles InSight®, General Electric) administered at the bedside, prospective data collection regarding medical, osteoporosis, ovarian, nutritional, and family histories, current injuries and mechanism, T- and Z-scores. For patients screening positive for osteoporosis (T-score <-1.6), intervention was initiated with (1) patient education, (2) initiation of calcium supplement therapy, and (3) referral to the patient's primary care physician.

RESULTS: Osteoporosis or osteopenia was found in 104 patients (43%). Intervention with education and initiation of medical therapy was achieved in all but four of these patients (96%). Only 16 patients (15%) had been previously diagnosed with osteoporosis and only 3 of these patients were being treated. Risk factors for osteoporosis demonstrated in this series include age, >2 medical problems, family history, and cessation of ovarian function.

CONCLUSIONS AND SIGNIFICANCE: Osteoporosis appears to have been dramatically underdiagnosed and undertreated in orthopedic trauma patients. Up to 98% of our patients would likely not have been treated for osteoporosis without initiation of this "osteoporosis protocol." It appears that orthopedic trauma surgeons may relatively easily play a role in diagnosing and treating osteoporosis, which ultimately may prevent secondary fractures.

♦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).