Abstracts

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Summary:
Our study finds that machine learning algorithms may be used to compare the risk of failure of specific patient-procedure combinations in the treatment of cartilage defects of the knee.

Data:
Background: Many treatment options exist for focal cartilage defects of the knee. There is, however, a lack of evidence-based methods to determine the optimal treatment of these injuries. Purpose: To develop machine learning algorithms to predict failure of surgical procedures that address cartilage defects of the knee and detect the most valuable variables associated with failure. Study Design: Case-control; Level of evidence, 3. Methods: A single institution prospectively collected database of cartilage procedures was queried for procedures performed between 2000 and 2018. Failure was defined as revision cartilage surgery and/or knee arthroplasty. One hundred and one preoperative and intraoperative features were evaluated as potential predictors. The dataset was randomly divided into training (70%) and independent testing (30%) sets. Four machine learning algorithms were trained and internally validated. Algorithm performance was assessed using area under the curve (AUC) and the Brier score. Local Interpretable Model-agnostic Explanations (LIME) was utilized to assess the optimized algorithm fidelity. Results: A total of 1091 patients who underwent surgical procedures addressing cartilage defects in the knee with a minimum of 2-years of follow-up were included. The most-common procedure was chondroplasty (n=560; 51%) followed by osteochondral allograft transplantation (n=306; 28%), microfracture (n=150; 14%), autologous chondrocyte implantation (n=39; 4%), and osteochondral autograft transplantation (n=56; 3%). The mean follow-up was 3.5±2.8 years. The mean age was 40.5±15 years. There were 205 (18.8%) patients who failed at final follow-up. The Random Forest algorithm was found to be the best performing algorithm, with an AUC of 0.765 and a Brier score of 0.135. The most important features for predicting failure following surgical procedures addressing cartilage defects of the knee were symptom duration, age, body mass index (BMI), and lesion grade. LIME analysis provided a patient-specific comparison for the risk of failure of an individual patient being assigned various types of cartilage procedures. Conclusion: Machine learning algorithms were accurate in predicting the risk of failure following cartilage procedures of the knee, with the most important features in descending order being symptom duration, age, BMI, and lesion grade. Integrated human and machine learning decision-making may improve patient selection and bring about the new era of patient-tailored evidence-based clinical care.

Category: Knee - Cartilage
Osteochondral Allograft Transplantation Using Dowell Technique for the Treatment of Steroid-Associated Osteonecrosis of the Femoral Condyles: Arthroplasty-Free Survival at 5 and 10 Years

Abstract ID# 22975
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Summary:
Steroid-associated osteonecrosis of the femoral condyles treated with dowel OATS technique has 88%, 85%, 60% arthroplasty-free survival at 5, 8, 10 years.

Data:
Introduction Steroid-associated osteonecrosis of the femoral condyles is a known complication of long-term or high dose steroid exposure. This is not an infrequent situation for patients with inflammatory conditions such as Lupus or Ulcerative Collitis and in patients with malignancies such as leukemia requiring bone marrow transplant. Historically, osteonecrosis was a contraindication for osteochondral allograft transplantation (OATS), however, recent evidence has indicated OATS maybe a durable treatment option. While results using the shell OATS technique has been reported in the steroid-associated osteonecrosis population, there is a dearth of information on the long-term survival for the newer dowel OATS technique. The aim of this study was to retrospectively analyze survival of OATS using the dowel technique for the treatment of steroid-associated osteonecrosis of the femoral condyles. Methods: Institutional database was queried to identify eligible patients between 2006 and 2020. Inclusion criteria included diagnosis of aseptic or secondary osteonecrosis of the distal femur, osteochondral allograft transplantation surgical treatment, dowel OATS technique, and history of steroid use for a medical condition. Exclusion criteria included previous cartilage restoration or arthroplasty surgery and incomplete records. No age criteria were used to exclude patients. Patient charts were reviewed for demographic details, information about underlying pathologic condition and steroid exposure, surgical details, and revision OATS or conversion to arthroplasty. Primary outcomes were arthroplasty-free survival and revision-free survival. Results: 27 knees in 25 patients with an average age of 27.6 years (range 16-59 years) were identified with an average follow up of 6.2 years (range 0.7-22 years). Medical conditions included 10 malignancies (5 post-bone marrow transplant) and 13 autoimmune diseases. Distribution of osteonecrosis of the femoral condyles included 1 isolated medial condyle, 5 isolated lateral condyles, 21 medial and lateral condyles. All patients underwent dowel OATS technique. Patients received on average of 2.2 grafts (range 1-5 grafts) with an average combined graft area of 6.67 cm2 (range 1.5 to 20.4 cm2). 10 patients had concomitant procedures and 10 patients had supplemental graft fixation. Arthroplasty-free survival was 88%, 85%, 60% at 5, 8, 10 years. Revision OATS or arthroplasty-free survival was 81%, 77%, 55% at 5, 8, 10 years. Graft failures included 1 revision OATS at 7.7 years secondary to cartilage delamination and 4 conversions to total knee arthroplasty at 1.6, 1.9, 8.7, 9.5 years. Conclusions: Osteochondral Allograft Transplantation is an acceptable and durable treatment option in patients with steroid-associated osteonecrosis with 88% arthroplasty-free survival at 5 years and 60% arthroplasty-free survival at 10 years. Future studies should capture patient reported outcomes and investigate factors leading to arthroplasty conversion such as age at time of OATS, etiology of osteonecrosis, extent of osteonecrosis.

Category: Knee - Cartilage
Osteochondritis Dissecans Lesions of the Posteroentral Femoral Condyle: Choosing the Optimal Surgical Approach

Abstract ID# 23216
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Summary:
Depending on location, anterior-based and posterolateral surgical approaches can both be effective for the treatment of posteroentral OCD lesions, however tubial tubercle osteotomy does not appear to significantly add to improved surgical exposure.

Data:
Background Osteochondritis dissecans (OCD) lesions of the lateral femoral condyle have a higher rate of instability and reduced rate of healing as compared to the more commonly described lesions of the medial femoral condyle. Unfortunately, lateral femoral condyle lesions are often located more posterior on the femoral condyle and thus more challenging to manage surgically. Effective, reproducible surgical approaches for operative management of lateral femoral condyle lesions have not been described. The aim of the study was to characterize reliable surgical exposure techniques for lateral femoral condyle OCD lesions. Methods This was a study of surgical approaches involving fresh whole-body cadaveric specimens (12 knees from 6 cadavers). All knees underwent a series of surgical approaches to evaluate the percentage of the articular surface that could then be adequately visualized. This included assessing the percentage of overall exposure of the lateral femoral condyle articular surface, as well as the percentage of exposure of the posterior region of the lateral femoral condyle articular surface (region encompassed by a line extending along the posterior cortex of the femur and its intersection with the femoral articular cartilage to the posterior articular chondral border of the femur). The following approaches were examined: lateral parapatellar, medial parapatellar with patellar eversion, lateral parapatellar with tubial tubercle osteotomy (TTO), medial parapatellar with TTO, posterolateral, and a posterior. Buried Kirschner wires were used to fluoroscopically demarcate the extent of exposure of the articular surface permitted by each surgical approach. One-
factor analysis of variance (ANOVA) was used to compare mean surgical approach visualization percent differences. If a significant difference was detected, a Tukey post hoc test was conducted. Results: The percentage exposure of the overall lateral femoral condyle for each approach were as follows: posterior 18.4%, posterolateral 27.3%, medial parapatellar with patellar eversion 76.8%, lateral parapatellar 80.1%, medial parapatellar with TTO 80.8%, and lateral parapatellar with TTO 84.4%. Of anterior-based approaches, there was a significant difference in the percentage of exposure of the lateral femoral condyle between the lateral parapatellar approach with TTO and the medial parapatellar approach with patellar eversion (84.4% vs. 76.8%, p < 0.02), otherwise all other anterior-based approaches had a similar percentage of articular surface exposure. The lateral parapatellar approach with TTO provided the highest percentage of exposure involving the posterior region of the lateral femoral condyle (67.9%), however only the posterolateral and posterior approaches allowed visualization of the most posterior chondral region of the femoral condyle. The posterolateral approach had a significantly greater area of exposure of the posterior lateral femoral condyle than the posterior approach (62.3% vs. 41.4%, p < 0.0001). Conclusion: For OCA lesions involving the lateral femoral condyle, all anterior-based approaches can provide reliable exposure to the majority of the lateral femoral condyle articular surface. However, for lateral femoral condyle OCD lesions that extend far posteriorly, the posterolateral approach may be the most reliable approach to gain adequate exposure. Lastly, addition of a TTO does not appear to add significant improvement in exposure of the lateral femoral condyle articular surface versus a similar approach without TTO.

Category: Knee - Cartilage

Association of Sex Mismatch Between Donor and Recipient with Short-Term Clinical Outcomes After Osteochondral Allograft Transplantation

Abstract ID#: 23616
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Summary:
This study found no observable differences in short-term clinical outcomes, patient satisfaction, or complications/reoperation rates based on sex of the graft donor in patients undergoing osteochondral allograft transplantation.

Data:
Purpose: Donor or graft-related characteristics have been increasingly examined in patients receiving osteochondral allograft (OCA) procedures to identify potential contributors for adverse outcomes. While favorable outcomes have been reported for patients undergoing OCA transplantation, there are still reports of return to sport ranging from 60-80% and reoperation rates up to 30-40%. Prior reports have suggested increased risk of graft failure long term in patients with graft donor-recipient sex mismatch. Therefore, the purpose of this study was to evaluate the potential effect of donor-recipient sex mismatch in OCA transplantation with respect to clinical outcomes, satisfaction, and return to sport (RTS). Methods: This retrospective study identified patients who underwent osteochondral allograft (OCA) transplantation of the knee at a single institution with a minimum of 1 year of clinical follow-up. Patient-reported outcomes were measured using the Visual Analog Scale (VAS) for pain and satisfaction and the Knee Injury and Osteoarthritis Outcome Score (KOOS). RTS and complications were analyzed. Complications included, infection, need for readmission, deep vein thrombosis/pulmonary embolism, need for reoperation, and graft failure. Patients were divided into two cohorts (same-sex donor (SS) and different-sex donor (DS)) and outcomes were compared between these two groups using 7-tests and chi-square analyses. ANCOVA and logistic regression models were used to control for confounders. Subsequent sub-analyses were performed to identify differences between the four donor-recipient groups (male-male, female-male, male-female, and female-female) using ANOVA and Chi-square analyses. Results: A total of 80 patients were included (50 in same-sex donor group and 30 in the different-sex donor group) with a mean follow-up of 41.1 ± 22.5 months. There was a difference in age between the groups (37.9 ± 12.0 years in the same-sex group vs. 30.5 ± 9.4 years in the different-sex group, p = 0.005), but no difference in BMI. No differences were observed between the SS and DS groups with respect to satisfaction, pain, and KOOS outcome scores with the mean satisfaction of the SS donor group being 72.8 ± 27.9 and 80.2 ± 29.9 for the DS donor group. After controlling for age, the differences remained not significant. 63.3% of same-sex donor patients returned to sport compared to 53.6% (p = 0.404). The overall complication and reoperation rates were 26.3% and 25.0%, with no difference between the DS and SS groups. There were two graft failures noted, both of which were in the same-sex donor group (male donar-male patient) with no difference. The majority of patients in the SS donor group were male-male (n = 37) and the majority of patients in the DS donor group were male donors for female patients (n = 25). When dividing into the respective donor-recipient groups, there was also no difference between the groups with respect to clinical outcomes, satisfaction, and rate of RTS. Conclusion: There were no observable differences in short-term clinical outcomes, patient satisfaction, or complications/reoperation rates based on sex of the graft donor in patients undergoing OCA transplantation. Further studies should be performed with longer term follow-up to determine the influence of donor sex on clinical outcomes in patients with OCA procedures in the knee.

Category: Knee - Cartilage

S-year Outcomes of One-Step Autologous Minced Cartilage Procedure for the Treatment of Knee Joint Chondral- and Osteochondral Lesions

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Summary:
Mincited cartilage procedure for medium to large chondral- or osteochondral lesions of the knee show good patient-reported mid-term results with low complications and reoperation rates and are a viable, single-stage alternative to more conventional techniques.

Data:
Background: Cartilage injuries in the knee are frequent but their treatment remains challenging. Minced cartilage is a one-step, autologous procedure with promising short-term results. Purpose: The aim of the present study was to evaluate mid-term results in a patient cohort treated with the minced cartilage procedure due to chondral- and osteochondral lesions of the knee. Study design: Prospective Case Series Methods: From February 2015 through June 2016, a total of 34 consecutive patients were treated with a single-step, autologous minced cartilage procedure for treatment of chondral and osteochondral lesions across the knee joint. Magnetic resonance imaging (MRI) was obtained pre- and postoperatively. The primary outcome measures were the numeric analogue scale (NAS) for pain and knee function, which were obtained prior to surgery and at 12, 24 and 60 months postoperatively. Additionally at final follow up the Lysholm score, Tegner activity score and the International Knee Documentation Committee (IKDC) score were obtained. Results: A total of 28 patients (44.1% females, mean age at surgery: 29.5 ± 11.5 years) were available at a mean follow up of 65.5 ± 4.1 months. Mean defect size was 3.5 ± 1.8 cm2 and manageable AMADEUS score (Area Measurement and Depth and Underlying Structures) was 55.2 ± 21.5. NAS for pain decreased from a median of 7 (range: 2-10) preoperatively to 2 (0-7), 1 (0-5) and 2 (0-8) after one, two and five years respectively. Knee function improved from a median of 7 (range: 2-10) to 3 (0-7), 2 (0-7) and 3 (0-7) after one, two and five years respectively. Lysholm-, Tegner activity- and IKDC score were 76.5 ± 12.5, 4 (min – max: 3-9) and 71.6 ± 14.8 at final FU, respectively. The average overall MOCART score for all examined patients and anatomical sites (patellar, femoral condyle, trochlea) was 62.6 ± 15.8. Four surgery related adverse events with necessary revision operation occurred during the five-year period. Conclusion: Mincited cartilage procedure for medium to large chondral- and osteochondral lesions of the knee show good patient-reported mid-term results with low complications and reoperation rates and are a viable, single-stage alternative to more conventional techniques.