

COA Paper Session 18: Sports Lower Extremity •

Moderators Michael Gilbart, BC, and Denis Atkinson, President of the New Zealand Orthopaedic Association

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Return to Sport Following Single-Bundle ACL Reconstruction: Patellar Tendon Autograft versus Hamstring Autograft

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Purpose: This study sought to examine return to sports in athletes younger than 25 following ACL reconstruction with either patellar tendon (PT) or hamstring (HS) autografts using a matched-pairs case-control experimental design. **Method:** Twenty-three matched pairs were obtained based on gender (56.5% Female), age (18.3±2.5yrs PT vs. 17.6±2.6 HS), and length of follow-up (4.7±2.1yrs PT vs. 4.2±1.6 HS). All patients reported participating in very strenuous (soccer, basketball etc.) or strenuous (skiing, tennis etc.) sporting activity 4-7 times/ week prior to their knee injury. Outcomes other than return to play included the IKDC, SAS, ADLS, SF-36, knee range of motion, laxity, and hop/jump testing. **Results:** Most patients in both groups were able to participate in very strenuous or strenuous sporting activity at follow-up [18 (78.3%) PT vs. 19 (82.6%) HS]. However, only 13 (56.5%) of the patellar tendon subjects and 10 (43.5%) of the hamstrings patients were able to return to pre-injury activity levels in terms of frequency and type of sport (p=.63). Hamstrings patients showed higher ADLS (p<.01) and SAS (p<.01) scores and better restoration of extension (p<0.05). **Conclusion:** While autograft and allograft patellar tendon ACL reconstruction exhibit similar clinical outcomes in high-demand individuals, autogenous hamstring grafts may lead to better subjective outcomes in young patients who participate in very strenuous levels of activity. Both graft options only allowed approximately half of the injured athletes to return to their previous level of sporting activity.

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The 2-5 Year Results of Primary ACL Reconstruction Using Doubled Tibialis Anterior Allograft

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Purpose: To report the 2-5 year results of ACL reconstruction with doubled Tibialis anterior allograft. **Method:** Seventy-three patients who underwent primary ACL reconstruction with doubled tibialis anterior allografts with minimum 2 year follow-up were included in the study. Patients were assessed via telephone interview using the Lysholm knee score, Tegner activity score, and the subjective International Knee Documentation Committee rating. In addition, they were asked if they had failure of the ACL requiring revision or any other procedures such as repeat arthroscopy for

meniscal surgery/articular cartilage. Statistical analysis using Levene's test and the T-test was used to assess outcomes of patients according to age and sex. **Results:** Sixty-four (88%) patients were available for follow-up. The mean age was 28.94 years (16-55). There were 33 males (51.6%) and 31 females (48.4%). The mean follow-up was 41.6 months (range 24-55 months). There were 2 (3%) complications, 1 patient suffered a DVT with subsequent PE, and 1 patient suffered a hardware problem. Four patients (6.3%) had failure of their graft and 6 patients (9%) required repeat arthroscopy. The mean Lysholm score was 91.75 (SD \pm 8.2), and the mean Tegner activity score was 5.4 (range 1-10). The mean IDKC was 88.94 (SD \pm 8.33). According to the IDKC score 58% of patients were rated as excellent, 27% as good, and 13% as fair and 2% as poor. There was no difference in outcome in patients under 30 compared to over 30 years. Males performed statistically better on the Lysholm and the IKDC scores (p 0.005 and 0.038 respectively) when compared to women. **Conclusion:** ACL reconstruction with Allograft Tibialis anterior tendon provided good functional results with a low failure rate at 2-5 years. There was no statistical difference in outcome between Patients under 30 years and those above 30 years. Males performed better on the Lysholm and the IDKC questionnaires.

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Patellar Tendon ACL Reconstruction in the High-Demand Patient: Allograft versus Autograft Reconstruction

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Purpose: This study sought to compare clinical outcomes and return to activity in high-demand patients following ACL reconstruction with either autograft or allograft patellar tendon using a matched-pairs case-control experimental design. **Method:** Nineteen matched pairs were obtained based on gender (36.8 % female), age (27.9 \pm 8.1yrs autograft versus 28.1 \pm 9.1 allograft), and length of follow-up (9.1 \pm 2.7yrs autograft versus 10.3 \pm 2.6 allograft). All patients reported participating in very strenuous (soccer, basketball etc.) or strenuous (skiing, tennis etc.) sporting activity 4-7 times/week prior to their knee injury. Patient-reported outcomes included the IKDC Subjective Knee Form, Activities of Daily Living (ADLS) and Sports Activity Scales (SAS) of the Knee Outcome Survey and SF-36. Range of motion, laxity, and functional strength were also assessed. **Results:** There were no significant differences in patient-reported or clinical outcome measures. Sixteen (84.2%) subjects undergoing autograft reconstruction and 12 (63.2%) subjects reconstructed with allograft were able to participate in strenuous or very strenuous sporting activity at follow-up (p =.34). Similar percentages of subjects were able to return to their pre-injury level of sports activity [12 (63.2%) autograft vs. 11 (57.9%) allograft; p =1.0]. Fewer subjects undergoing reconstruction with autograft reported instability with very strenuous activity [5 (26.3%) autograft vs. 12 (63.2%) allograft], but this difference was not significant (p =.07). **Conclusion:** While autograft and

allograft patellar tendon ACL reconstruction exhibit similar clinical outcomes in high-demand individuals, autogenous patellar tendon grafts may be indicated to allow patients to return to very strenuous levels of activity.

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Soccer and ACL Reconstruction in Teenage Girls

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Purpose: Females are at greater risk for anterior cruciate ligament (ACL) injury than males. Soccer may be a significant risk factor for ACL injury in adolescent females. ACL injury has significant consequences, including early onset of osteo-arthritis. The purpose of the study was to determine a) the number of ACL reconstruction surgeries performed on females between the ages of 13-18 inclusive in the Capital Health (CH) region from December 2000 to November 2005, and b) those due to soccer injuries. Secondly, we describe factors relating to the mechanism of injury. **Method:** Utilizing regional administrative data, we performed a standardized chart review and telephone interviews with female adolescents who underwent ACL reconstruction in the aforementioned time period. Information gathered included: a) Age at reconstruction procedure. b) Indoor versus outdoor soccer playing surface. c) Level of play and frequency of participation. The Alberta Soccer Association provided the number of registrants in indoor and outdoor seasons over the same time period. **Results:** 2,824 ACL reconstruction operations were performed between December 2000 and November 2005. Reconstructions in females took place at an earlier age than in males. There were 266 ACL reconstructions in 256 adolescent females, of which 253 charts were available for review. One hundred and eleven (44%) knees were injured during soccer play. Seven patients with eight ACL reconstructions who injured their ACL playing soccer could not be located. ACL injuries occurred during indoor soccer in 52 (51%) cases despite higher registration in outdoor soccer during the same timeframe. 77 (74%) subjects played competitively and 81 (79%) subjects played two or more times/week. **Conclusion:** Approximately 10% of ACL reconstructions were performed on adolescent females. Nearly 50% of ACL injuries occurred during soccer play, with a similar number seen in indoor versus outdoor play. Study limitations include the use of administrative data to assess the number of ACL reconstructions rather than ACL injuries. An awareness of the propensity of knee injuries in female soccer players is important. With the increased participation of young females in soccer and the serious lifelong implications of ACL rupture, prevention and training should be improved to lower the incidence of injury.

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Reliability of Tunnel Angle in ACL Reconstruction: Free Hand versus Mechanical Guide Technique

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Purpose: The increasing number of ACL reconstructions has led to the introduction of new techniques irrespective of the fact optimal tunnel angle placement has yet to be established. Improper tunnel angle placement is associated with a variety of complications including graft failure. The purpose of this retrospective study was to compare the reliability of tibial tunnel angles produced by two experienced surgeons using a free hand method or mechanical guide (Howell™ 65° Tibial Guide). **Method:** Tibial tunnel angles in the coronal and sagittal planes were determined from anteroposterior and lateral radiographs, respectively, taken at 2 to 6 months postoperatively. Fifty-two sets of digital radiographs were analyzed (free hand = 28, mechanical = 24) with the knee in full extension 100 cm from the beam source. Tunnel angle measurements were calculated using NIH ImageJ software. Each angle was measured by two investigators on three separate occasions with minimum 7 days between each analysis. **Results:** There was a significant difference ($p < 0.05$) in tibial tunnel angle placement between the mechanical guide (64.76 ± 5.88) and free hand (61.11 ± 5.04) group in the coronal plane. No significant difference in tibial tunnel placement in the sagittal plane was detected (mechanical guide = 73.63 ± 7.69 , free hand = 73.51 ± 6.68). Intra-rater and Inter-rater reliability for measurements in the sagittal (ICC = 0.809; 0.733) and coronal (ICC = 0.69; 0.812) plane ranged from high (> 0.75) to moderate (0.75 – 0.40), respectively. **Conclusion:** Tibial tunnel angles in the coronal plane produced with a mechanical guide are more accurate than those drilled free hand when the intended angle of placement is 65°. The method used to measure tibial angles in this study was reliable within and between investigators. Further research will be conducted to investigate the correlation between tunnel angle placement and patient outcome measures.

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The Ottawa Treatment Protocol for Septic Arthritis Following ACL Reconstruction

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Purpose: To present our clinical and quality of life outcomes after one year treatment with our protocol including graft retention. **Method:** Seventeen of 1, 847 patients who underwent ACL reconstruction surgery were identified as infected following retrospective chart review in our institution (University of Ottawa) from 1995 to 2005. Mean age was 37 years old (range 18-56). Gender ratio was 14 male/ three female. Laterality 13 left/ four right knees. The diagnosis was achieved by clinical suspicion and serum markers (ESR, CPR, WBC) followed with aspiration and culture of intraarticular liquid. After that, our treatment protocol included IV antibiotics (empiric and culture guided) and knee arthroscopy performing debridement and lavage with 12L of saline irrigation as well as graft retention when possible. Clinical and Radiographic data were collected at a minimum of one year follow-up (IKDC, KT-1000, Lysholm, SF-12, Tegner, Cybex Strength testing). **Results:** The

Incidence of septic arthritis following ACL reconstruction was 0, 92%. Bacteriology results were as follows: seven staphylococcus aureus, four Propionibacterium acnes, one Klebsiella oxytoca, five no growth. The time from ACL reconstruction to first symptoms of infection was 37 days (range 4-63). The time from symptoms to arthroscopic debridement was 5, 5 days (range 0-33). Serology markers were as follows: ESR mean 69 (range 23-128), CPR 136 (50-387), WBC 10.3 (6-15). The average follow up was 41 months (range 12-85). Sixteen of 17 grafts were retained after 1.53 procedures per patient. Antibiotic treatment lasted 5.2 weeks on average. The average clinical outcomes were: Lysholm 77 (44-98), IKDC 74 (46-95), Quadriceps strength 71 % of non operative side, and Hamstrings strength 70 % of non operative side, KT -1000 side to side difference 1 mm (-3 to 4). Degenerative radiological changes were noted in three patients. Two later repeat reconstructions occurred due to instability (11,1%). No delayed recurrence of infection was noted. **Conclusion:** ACL reconstruction is a safe procedure being the incidence of septic arthritis in our series of 0, 92%. Our protocol of treatment is clinically effective and allows for a stable knee in 88, 9% of the patients avoiding the appearance of a delayed infection.

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Automatic Classification of 3D Kinetic Data of Healthy and ACL Deficient Participants

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Purpose: Gait analysis has become an innovative approach to assess the biomechanical adaptations due to an ACL injury. However, interpreting the large amount of data collected often requires an expert. Therefore, there is a need to develop an automatic method capable to distinguish kinetic pattern of an ACL deficient patients from an asymptomatic population. **Method:** 26 ACL deficient patients and 30 asymptomatic participants took part in a treadmill gait analysis. 3D ground reaction forces (vertical, medio-lateral and anterior-posterior) were collected using the ADAL 3D treadmill. Features were extracted from the 3D ground reaction forces as a function of time and then classified by the nearest neighbour rule using a wavelet decomposition method. The classification method was tested on our data base of 56 participants. **Results:** The proposed classification method obtained an accuracy of 90%. The classification accuracy per class was higher for the ACL deficient group allowing classifying correctly 25 out of 26 ACL deficient patient. 25 out of the 30 asymptomatic participants were properly classified. **Conclusion:** This study shows that an automatic objective computer method could be used in a clinical setting to help diagnose an anterior cruciate ligament injury during a gait analysis evaluation. Future studies should apply this method on a larger database including data from patients with other musculoskeletal pathologies to help diagnose other injuries.

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A Survey Study Regarding the Natural History and Treatment of Anterior Cruciate Ligament Injury Among Members of the Canadian Orthopaedic Association

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Purpose: To describe the current practices and opinions of members of the Canadian Orthopaedic Association (COA) pertaining to anterior cruciate ligament (ACL) reconstruction. **Method:** All orthopaedic surgeon members of the COA residing in Canada were sent an email invitation to take part in a survey via an internet-based survey manager. Expanding on a previously published survey (Marx et al., 2003), the current survey was comprised of 30 questions regarding the natural history of ACL-injured knees, surgical and post-surgical treatment choices, and success of the surgery. Clinical agreement was defined as greater than 80% agreement in choice of response option. **Results:** Two hundred and eighty-three surgeons (49.3%) responded to the survey. Responses of the 143 surgeons (50.5%) who indicated they performed ACL reconstruction in the last year are presented. Clinical agreement with respect to surgical technique was demonstrated with respect to only three practices - ipsilateral graft harvest (100%), single incision approach (86.1%), and manual graft tensioning (81.6%). In terms of natural history, the only area of agreement was that hamstring and quadriceps strength affects function in ACL deficient knees (92%). Although less than the clinical agreement threshold, a majority of surgeons indicated their preference for semitendinosis-gracilis autograft (73%), transtibial versus anteromedial portal for establishment of the femoral tunnel (65 versus 29%), notchplasty (65% only with impingement) and promotion of full weight-bearing and range of motion immediately post-surgery (72.1 and 74.8%, respectively). The most frequent surgeon-reported complications were tunnel widening (9.8%) and graft failure (4.4%). A greater proportion of high-volume surgeons used a manual tensioning device intra-operatively and permitted earlier return to sport ($p < 0.05$). **Conclusion:** In the rapidly evolving area of ACL reconstruction, no recent survey of practices and opinions of orthopaedic surgeons has been published. The current survey is more extensive than others conducted to date and attempts to involve all practicing orthopaedic surgeons in Canada. In addition to providing information from a Canadian perspective, such an undertaking allows surgeons to evaluate their treatment decisions based on those of their colleagues, and also presents areas of dissimilarity that can be targeted for more extensive research.

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Management of Multiple Ligament Injured Knee: A Survey of Current Practice in Canada

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Purpose: Treatment of knee dislocations remains challenging and controversial. Several strategies for the management of multiple ligament knee injuries have been described and there are multiple unresolved questions. These include the indications for surgery, repair versus reconstruction, surgical timing and graft selection. The aim of this survey was to identify areas of agreement and controversy, to define the current standard of care and help generate research questions. **Method:** Using the standard techniques for survey development we presented six clinical scenarios of acute knee dislocations (at least three ligaments) to all orthopaedic surgeons affiliated with Canadian medical schools. The scenarios were designed to cover the common combinations of knee dislocations in both a 25 year old active individual and a 50 year old sedentary individual. The responses were divided into three groups. Group A consisted of those with fellowship training, or practices focused on, sports knee. Group B was comprised of surgeons with trauma fellowship or a subspecialty trauma practice. Group C were the remaining surgeons without these subspecialty foci. We report on the responses of groups A and B. **Results:** An average of ten different treatment algorithms were reported for each scenario but there was agreement on the need for early surgical management in the young active individual with a knee dislocation and all dislocations involving a lateral sided injury. Conversely, there was a lack of consensus regarding the need for surgical treatment of the 50 year old individual with bi-cruciate injury and medial collateral ligament. The most common combinations of reconstruction and repair are reported for each clinical scenario. Surgeons strongly favor early surgical intervention, within three weeks of injury, except for the 50 year old sedentary individual with a bi-cruciate plus medial sided injury. Allograft was the most popular choice to reconstruct the PCL and lateral ligament. For the ACL graft there was a near equal distribution between hamstrings, patellar tendon and the use allograft tissue. **Conclusion:** In the absence of higher level evidence, the information from this survey helps define the standard of care in Canada and identifies areas of controversy which would be a priority for a multi-centre prospective trial.

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Posteromedial Corner Injury Patterns in Traumatic Knee Dislocations

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Purpose: Traumatic knee dislocations are complex injuries. A thorough knowledge of the pattern of ligament damage is essential to plan for definitive treatment. Injuries to the structures of the posteromedial corner (posterior oblique ligament, the semi-membranosus tendon and its expansions, the menisiofemoral and meniscotibial ligaments, posterior horn of the medial meniscus and posterior reflections of the deep and superficial medial collateral ligament) can contribute to rotational laxity and have not

been previously described in the setting of knee dislocations. We set out to evaluate the injury patterns of the posteromedial corner in a series of traumatic knee dislocations. **Method:** A radiographic (MRI) study was conducted on 22 multi-ligament knee injuries in 22 patients, managed at a level one trauma centre by a single surgeon between July 2006 and May 2008. **Results:** There were 14 male and 6 female patients with an average age of 29. The mechanism of injury was high velocity in 10 cases, and low velocity in 12 cases. One case (ACL/PCL/posterolateral corner injury) was associated with a vascular injury. While the incidence of MCL injury was 59%, injury specific to the PMC was evident on MRI in 81.8% (18/22) of cases. The deep and superficial MCL were involved in 13/18 and 12/18 PMC injuries, respectively. The posterior oblique ligament was injured in 11/18 cases and the semi-membranosus and its expansions were injured in 10/18 cases (all distal). Injuries to the posterior horn of the medial meniscus (9/18 cases) were associated with a tear of the meniscofemoral/meniscotibial ligaments in all cases. **Conclusion:** Injury to the PMC was common with high-grade multi-ligament knee injuries in this series. PMC injuries were more common than MCL injuries alone. Injury to the posterior horn of the medial meniscus was predictive of more extensive PMC injury in all cases. The posteromedial corner of the knee is an under recognized area where important injuries can occur in the setting of a dislocatable knee. Future research will involve the correlation of the injury patterns described in this series to clinical measures of knee instability and laxity.