Early or Delayed Skeletal Maturity Confers an Increased Incidence of Concomitant Meniscal and Chondral Pathology in Pediatric and Adolescent Patients Undergoing Primary Anterior Cruciate Ligament Reconstruction

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INTRODUCTION: Anterior cruciate ligament (ACL) rupture is associated with meniscal and chondral injury. These injuries have been studied in adult cohorts; however, the incidence of and risk factors for these injuries in the adolescent population are not well defined. To our knowledge, there is no comparison of injury incidence between the skeletally immature (SI) and skeletally mature (SM) populations.

METHODS:

A retrospective cohort study was conducted to compare the incidence, need for treatment, and predictive factors associated with concurrent meniscal and/or chondral injury in SM versus SI patients undergoing primary ACL reconstruction (ACLR). Subjects aged 21 and below who underwent primary ACLR between January 2012 and April 2020 were retrospectively reviewed. Skeletal maturity was determined via radiographs. Laterality, location, severity/pattern, and treatment of meniscal and chondral injuries were recorded. Data was analyzed for patient-specific factors affecting incidence of meniscal and chondral injury. Logistic regression was utilized to identify predictors of intra-articular pathology. Interaction variables were included to parse specific impacts of non-independent predictors.

RESULTS: SM patients sustained higher rates of meniscal injury (p = .014). Lateral meniscal pathology differed in SI and SM patients. SI patients were more likely to have vertical-longitudinal tears (p < .001) in the posterior horn (p = .004) , while SM patients were more likely to sustain radial (p < .001) or complex (p - .009) tears located in the meniscal body (p = .038) . SM patients were more likely to undergo partial meniscectomy (p = .022), while meniscal injuries were more likely to be observed in the SI cohort (p < .001). In the SM cohort, chondral injury incidence increased in the presence of meniscal injury (OR 2.96, 95% CI [1.83 ,4.99], p < .001). While ACL injuries more frequently occur without contact, SI patients were more likely to sustain ACL injury during contact (p = .004). Male sex conferred a higher likelihood of meniscal injury (OR 0.59, 95% CI [0.43, 0.81], p = .001). BMI was a prognosticator of medial sided pathology, both meniscal (OR 1.04, 95% CI [1.01, 1.06], p = .002) and chondral (OR 1.05, 95% CI [1.02, 1.09], p < .001). Skeletal maturity was a better predictor of intra-articular pathology than age in an adolescent cohort for all categories - overall meniscal injury (OR 0.01, 95% CI [0.00, 0.16], p = .003), MMT (OR 0.00, 95% CI [0.00, 0.06], p =.002), LMT (OR 0.03, 95% CI [0.00, .75], p =.034), and chondral injury (OR 0.00, 95% CI [0.00, 0.49], p = .049). Interaction analysis established that patients with early or delayed physeal closure compared to similarly aged peers are at increased risk of concomitant intra-articular injury.

DISCUSSION AND CONCLUSION:

This study identifies differences in meniscal tear patterns and locations and chondral pathology that occur at increased rates dependent upon skeletal maturity, likely based upon biomechanical changes during development, which may affect pre-operative counseling and/or intra-operative decision making. Additionally, skeletal maturity significantly predicted concomitant intra-articular injury associated with ACL rupture in pediatric and adolescent cohorts, emphasizing the impact of early or delayed physeal closure on increased risk of intra-articular injury. Identification of populations at-risk for concomitant meniscal and chondral injury and prompt intervention may help improve outcomes, in pediatric and adolescent ACLR.