Physeal Sparing ACL Reconstruction and Deformity after Pediatric ACL Reconstruction

Robert G. Marx, MD MSc FRCSC
Sports Medicine and Shoulder Service
Hospital for Special Surgery
New York, New York

I. Timing the Surgery
a. Non-op treatment of ACL-injured children/adolescents is controversial
   i. Risk of intra-articular injury, functional impairment and joint degeneration (McConkey M et al, 2011)
   ii. Decide between:
      1. Early reconstruction with open physes
         a. Activity restriction often difficult with children
         b. Delaying surgery increases risk of meniscal and intra-articular injuries
         c. Growth disturbances are rare
      2. Delayed reconstruction until physeal closure
         a. Most ACL injured children are 6-12 mo from skeletal maturity
         b. Allows for anatomical adult-like reconstruction
            i. Surgeons are more familiar with this
         c. Absolute activity restriction is key to reducing risk of additional knee injuries
   d.

II. Growth plate anatomy
a. Correctly navigating the growth plates is critical in pediatric ACL reconstruction
   i. “Modeling the growth plates in the pediatric knee” (Guarino J et al, 2004)
   b. Available techniques (McConkey et al, 2011)
      i. Physeal-sparing (intra-articular)
      ii. Partial transphyseal (over the top)
      iii. Partial transphyseal
      iv. Complete transphyseal
   c. “Physeal Sparing Reconstruction of the ACL using Extra-articular and Intra-articular ITB” (Kocher et al, JBJS(Am) 2005)
      i. 44 patients followed for mean 5.3 years
         1. Tanner stages 1 and 2 only
         2. Mean age 10.3 years
      ii. 2 Failures, rest had negative pivot shifts
      iii. Mean Lysholm score 95.7
      iv. NO growth arrests or deformities

III. Physeal Damage
a. ACL tunnels filled with soft tissue grafts are less likely to form physeal bars compared with empty tunnels
b. Overtensioning of transphyseal grafts in skeletally immature individuals may predispose to growth disturbance
c. The presence of bioabsorbable devices affects the chance of growth disturbance
d. Damage to less than 5% of the physis is unlikely to affect growth, but injury to 7–9% of the physis may cause a growth disturbance (“threshold of injury”) (McConkey et al, 2011)
   i. The % volume of the physis that is removed or damaged is determined by:
      1. Age (size of physes)
      2. Drilling Angle
      3. Tunnel Diameter (has greatest effect)

IV. Case Reports
a. “Growth Arrest of the Tibia After ACLR Lengthening and Deformity Correction With the Taylor Spatial Frame” (Rozbruch R et al AJSM)
   i. 17 yo boy with acquired limb-length discrepancy
   ii. Skiing injury at age 12
   iii. Transphyseal ACL reconstruction (no tunnel on femoral side)
b. “Valgus Deformity After Reconstruction of the ACL in a Skeletally Immature Patient” (Koman et al JBJS 1999)
   i. 14 yo boy injured playing football; non-op treatment failed
   ii. Transphyseal intra-articular reconstruction of the ACL
   iii. 2 years after surgery: 14 degrees of valgus angulation of the distal part of the right femur
      1. Corrective opening-wedge osteotomy of right femur
      2. Distal femoral epiphysiodesis performed concurrently on the left side
c. “Growth disturbances without growth arrest after ACL reconstruction in children” (Chotel F et al, KSSTA 2010)
   i. Patient 1
      1. 7 yo boy
      2. IT band graft was placed under the lateral collateral ligament, over the top of the lateral femoral condyle and through a transphyseal tibial tunnel with a diameter of 6 mm.
      3. Overgrowth phenomenon
         a. 15 mm discrepancy at two years
      4. At age 14, percutaneous epiphysiodesis by curettage of the femoral and tibial growth plate performed on left knee
   ii. Patient 2
      1. 10.5 yo boy
      2. Same procedure as patient 1
      3. At 2.5 years, medial tibial length was 1cm longer on operated side
4. Treated non-operatively with close follow up
d. “Growth Disturbance Following ACL Reconstruction with Use of an Epiphyseal Femoral Tunnel: A Case Report” (Lawrence et al, JBJS (Am) 2011)
   i. 14 yo boy underwent revision ACL surgery (primary reconstruction at 12 yo)
      1. ACL reconstruction with use of the epiphyseal femoral tunnel and a transphyseal tibial tunnel
         a. Arthroscopic confirmation of no physeal breach
   ii. 19 months following revision surgery, there was valgus deformity in the right knee