Introduction to Pediatric Sports Injuries: The Lower Extremity

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Disclosures: None
Objectives

Following this presentation, the motivated learner will be able to understand:

• The risks & how lower extremity injuries in pediatric sports injuries occur
• The treatment of specific lower extremity pediatric sports injuries
• Prevention strategies
Who Is Participating?

- Over 45 million children ages 6-21 engage in a sports program held outside of school (6)
- 75% of U.S. families have at least one child in a high school sport (6)
Positive Impact of Sports

• Physical activity
  • The CDC estimates approximately 50% of children are engaged in regular exercise
  • More than 1/3 of children born after 2000 will develop diabetes
  • Childhood obesity has tripled in last 40 years
  • Childhood obesity is a good predictor of adult obesity
    • Diminished quality of life: social discrimination, heart disease, decreased self-confidence

Positive Impact of Sports

• Improved Academic Achievement
  • In 2010, the CDC reported a positive correlation with sports participation and higher grades; obesity correlated with learning difficulties

• Decreased High-Risk Activities
  • Smoking
  • Illicit drug use
  • Carrying a weapon

• Binge drinking the exception

Positive Impact of Sports

• Overall Health Benefits for Girls
  • Decreased risk for developing:
    • Breast cancer
    • Osteoporosis
    • Future obesity
    • Heart disease
  • Decreased rates of:
    • Teen pregnancy
    • Unprotected sexual intercourse
    • Smoking
    • Drug use
    • Depression
    • Suicide

Positive Impact of Sports

Psychological Benefits

- Social support
- Friendships
- Peer interactions
- Goal setting
- Time management
- Emotional control
- Leadership
- Wisdom
- Social intelligence
- Cooperation
- Self-exploration
- Increased self-esteem
- Less anxiety
- Decreased risk of depression and suicide

Pressure to Perform

• 42% of injured youth athletes hide or downplay the injury so they can continue playing
  • Pressure from parents
  • Pressure from coaches
  • Pressure from teammates
Negative Impact of Sports

• The Sports-Medical Industry
  • The 8 most common recreational activities accounted for 2.24 million medically-treated injuries of the musculoskeletal system in children ages 5-14 (3)
  • More than 3 million emergency room visits each year for ages 5-24 from sports-related injuries
  • According to the National Center for Sports Safety, 3.5 million children under age 14 receive some sort of medical care for sports-related injuries each year

• The “Industry Cost Model”?...(3)
  • $2 billion (2001)
Risks

• Which sport has highest frequency of injury?
  • Girls cross country
  • Football
  • Wrestling
  • Girls soccer
  • Boys cross country
Coaches

• Fazarale et al
  • 73% of coaches reported they followed the rules for pitching regulation and rest requirements
    • However, they could only answer 43% of questions regarding pitching rules

• Yukutake et al
  • Only 40% of coaches had accurate knowledge of the guidelines
  • 28% reported compliance


Negative Impact of Sports

• Injuries
  • Increased tensile strength across growing bones during growth spurts
    • Growth occurs at the physis
    • Injuries occur at different anatomic structures compared to adults

Sports Injuries

• Injuries during adolescent years
  • Decreased flexibility
  • Decreased coordination
  • Decreased balance
Negative Impact of Sports

• Most injuries are sustained from repetitive trauma

• Rest (the most important), ice, and non-steroidal anti-inflammatory drugs (NSAIDS), e.g. aspirin, ibuprofen, naproxen, will normally alleviate the problem
Negative Impact of Sports

• The specialization of sports
  • More and more young athletes choosing to stay sports specific
  • Increases
    • Sports-related injuries
    • Peer isolation
    • Burnout
    • Psychosocial problems
    • Attrition
Negative Impact of Sports

• Earlier start
  • Numerous studies show “athletic performance at an early age is unreliable in predicting future ability to perform successfully in a chosen sport”

• The earlier a child is identified as being talented for a particular sport, the more uncertain the prediction for future success in that sport

Negative Impact of Sports

- Undiagnosed and untreated injuries can lead to long-term injuries that will affect the child well into adulthood
  - Recurrent shoulder injury leading to normal anatomy alteration
  - Recurrent elbow injury leading to chronic elbow instability
  - Recurrent ankle sprains leading to chronic ankle instability
Osgood-Schlatter Disease

- Apophysitis of the tibial tubercle
  - Rest
  - Ice
  - Compression
  - NSAIDs
Osgood-Schlatter Disease

• Can result in patella alta
  • Risk for patella dislocation and other patellofemoral disease
Osteochondritis Dessicans

- “A developmental condition of the joint in which the articular cartilage and underlying bone are involved”
- Occurs before physeal closure
- Exact etiology unknown, but most likely multiple factors
  - Mechanical trauma or stress in highly active children
Osteochondritis Dessicans

• Patient complains of activity-related knee pain
  • Non-specific location
  • Also may complain of giving way, locking, etc.

• Tenderness over the condyle

• Positive Wilson’s Test
Osteochondritis Dessicans

- AP, lateral, tunnel, and sunrise/Merchant view
- 2/3 of lesions on medial condyle
- MRI used to determine extent of articular cartilage involvement and stability of the lesion
Osteochondritis Dessicans

• Outcome better in
  • Stable lesions
  • Medial femoral condyle lesions
  • Less active patients
• Stable lesions did better with conservative treatment
• Unstable lesions did better with surgery
Osteochondritis Dessicans

Juvenile osteochondritis dissecans

- Child under age 13
  - Articular surface intact
    - Nonoperative treatment (crutches, casts, no sports)
      - 6–12 months
        - Healed
          - Arthroscopy—drilling (anterior or retrograde)
        - Non healed
      - Arthroscopy

- Child approaching maturity or atypical lesion
  - Nonoperative Rx for 6 months
    - Healed
    - Not healed
      - Arthroscopy drilling or fixation if detached

- Older adolescent or detached fragment on MRI
  - Arthroscopy
    - Intact or fissured
    - Detached
      - Drilling
        - 1. Prepare bed and fixation or
        - 2. Consider:
          a. Osteochondral graft (Mosaicplasty)
          b. Autologous chondrocyte transplantation
Quadriceps Contusion
**Quadriceps Contusion**

- Blunt trauma to anterior thigh severe enough to result in muscle hemorrhage
  - Thigh swelling, pain, loss of knee flexion
- Over next few weeks, granulation tissue forms
- Can mature into a dense collagenous scar and lead to significant disability
Quadriceps Contusion

• Treatment
  • RICE
  • KI and crutches initially
  • When pain and spasm subside, gentle AROM
  • Passive stretching to increase KF not permitted; will exacerbate bleeding and scar formation
  • Progressive strengthening and exercises permitted after 90° of KF is obtained

• Moderate to severe: 4-6 weeks before return to play
  • 120° of flexion
  • 80% strength of opposite leg
  • Functional gait

• If loss of KF and pain, surgical excision after 6 months
Quadriceps Contusion

- Anterior Compartment Syndrome
  - Rare
  - Severe thigh swelling and pain (can also occur if bleeding disorder present)
  - Causes muscle necrosis
  - SURGICAL EMERGENCY
Quadriceps Contusion

- Myositis Ossificans
  - Body develops bony tissue instead of muscle tissue
  - Surgical excision after 6 months
Acute Patellar Dislocation

- Occurs in ages 14-20, high-level athletes
- Usually underlying anatomical abnormality
- MPFL most important stabilizing structure of the patella
- Mechanism: Indirect force applied to knee causes the injury
  - An internal rotation moment is applied to the femur while the foot is planted, knee flexed and in valgus
    - Basketball, football, baseball, gymnastics
Acute Patellar Dislocation

• Patient usually describes twisting injury
• Knee often swollen
• Patella is almost always reduced
• If not reduced, the knee will usually be flexed and patella will be lateral
• Passively extend knee and gently apply medial force to the patella
• Usually underlying anatomical abnormality
Recurrent Patellar Dislocation

- Anatomic Factors
  - Increased Q angle
    - Normal is $\leq 10$ degrees
  - Excessive external tibial torsion
  - Femoral condylar dysplasia
  - Patella alta
  - Generalized ligamentous laxity
Acute Patellar Dislocation

Knee Effusion

Yes
Knee films and possibly an MRI
Chondral Defect Present?

Yes
Surgery

No
Look at Occurrence Rate

No
3-4 Occurrences?

Yes
Surgery

No
Brief Immobilization
Rigorous Rehab
**Acute Patellar Dislocation**

- **Rehab**
  - Brief immobilization then rehab
  - Aimed at resolving hemarthrosis, reducing pain, improving ROM and increasing quadriceps and hamstring strength
  - Use of patellar stabilizing brace recommended
  - After rehab, return to sports permitted, if no effusion and approx. 80% of strength
  - 50-60% of patients will not have a recurrence

- **Surgery**
  - Arthroscopic surgery required to remove loose fragment (<2 cm with little or no subchondral bone) or fix (>2 cm with subchondral bone)
  - Acute repair of medial structures or MPFL reconstruction
Recurrent Patellar Dislocation

• Surgery
  • 3-4 recurrences of patella dislocation and the instability affects lifestyle
  • Must correct anatomic variant if present

• Procedures
  • Lateral retinacular release
  • MPFL reconstruction
  • Vastus medialis advancement with lateral medial reefing or semitendinosus tenodesis
  • Distal realignment
Meniscal Tears

- Develop mature anatomic relations by 3 months gestation
- Mostly type 1 collagen with fibers in circumferential pattern
- Blood supply comes from periphery
  - By age 1, inner third is avascular
  - Adult vascular pattern present at 10 yrs
    - Red-red, red-white, white-white
    - Important for healing
Meniscal Tears

- Rare in children and adolescents
- Usually occur with ACL tears or if tear is abnormal in shape
  - Discoid meniscus
- Incidence increases with age
- Medial meniscus > lateral meniscus
- 30% are repairable
- Occur with twisting or pivoting motion during sports
  - Basketball, soccer, football
Meniscal Tears

- Symptoms
  - Pain along joint line
  - Effusion
  - Swelling
  - Giving way
  - Locking
Meniscal Tears

• Acute treatment: RICE
  • Rest
  • Ice
  • Compression
  • Elevation
Meniscal Tears

- Most symptomatic meniscal tears in children require surgical treatment
  - Arthroscopic inside-out or all-inside repair
  - Red-red zone or red-white zone
- Overall results excellent
ACL Tears

• Dodwell et al reported a 190% increase from 1990-2009 in rate of ACL reconstructions per 100,000, ages 3-20, in New York state (1)

• A 2012 study showed ACL injuries represent nearly 25% of all high school knee injuries (12)
Intrinsic Risk Factors for ACL

- Females 2-9x higher rate of non-contact ACL injury
- Decreased femoral notch width
- Decreased ACL volume
- Increased posterior slope
- Increased Q angle
- Increased anteversion
- Greater generalized ligamentous laxity
- Quadriceps dominant musculature
- Weak core and hip strength
Extrinsic Risk Factors for ACL

- Pivoting and cutting sports
- Footwear
- Weather conditions
- Playing surfaces
Prevention

Females

• Tend to be one leg dominant
  • Valgus with landing
  • One knee relatively straight
  • Most weight on one leg
  • Trunk tilted so center of mass is shifted to the outside
Tibial Eminence Fractures

- Peak age 8-14
- Controversy still exists over injury mechanism
  - Classically occurred from fall off a bicycle
  - Usually occurs with hyperflexion or hyperextension force, with or without varus or valgus, and a rotational moment
- The ACL is stretched or attenuated prior to fracture
- Swelling, pain, positive ACL tests
Tibial Eminence Fractures

• Acute Treatment
  • Rest
  • Ice
  • Compression
  • Elevation

• Symptoms
  • Pain
  • Swelling
  • Inability to perform straight leg raise test
Tibial Eminence Fractures

• Meyers and McKeever
Tibial Eminence Fractures

- Treatment based on displacement and ability to reduce with knee in extension
  - Type 1: 10-30° of knee flexion recommended
    - Cylinder cast from 4-6 weeks
  - Type 2 that won’t reduce and all Type 3: Surgery
    - Usually due to entrapped meniscus
    - Numerous fixation methods
      - Fracture pattern and surgeon experience
Tibial Eminence Fractures

• Closed treatment
  • 3-4 weeks in cast
  • Active ROM exercises and strengthening started immediately after cast is removed

• Surgery
  • Protected WB for 6 weeks
  • Return to sports after full ROM and most strength returns (3-4 months)

• Usually residual laxity in ACL but does not correlate with subjective symptoms
Ankle Sprain

• Half of all ankle sprains occur during athletic activity
• More common in adolescents
• Children more likely to damage distal fibular physis
  • Growth plates in children weaker than ligaments
Ankle Sprain

• Mechanism of injury: plantar flexion and inversion

• Lateral ligaments (anterior talofibular, calcaneofibular and posterior fibular ligaments) are injured
  • Can also damage deltoid ligament (mechanism of injury is pronation-abduction, pronation-external rotation and supination-external rotation of the foot)
Ankle Sprain

- Differentiate between physeal injury and ligamentous injury based on anatomic location of the pain and tenderness
  - Err on side of caution
  - Swelling, tenderness, followed by some bruising
Ankle Sprain

Lateral ankle sprain

- Normal
- Grade I sprain
- Grade II sprain
- Grade III sprain

Anterior talofibular ligament
Calcaneofibular ligament
Ankle Sprain

• Interosseous ligament sprain
  • In association with deltoid ligament
• Squeezing fibula and tibia together proximally causes pain
Ankle Sprain

Ottawa Ankle Rules
For Ankle Injury Radiography

A) Posterior edge or tip of lateral malleolus
B) Posterior edge or tip of medial malleolus
C) Base of 5th Metatarsal
D) Navicular

MALLEOLAR ZONE
MIDFOOT ZONE

LATERAL VIEW
MEDIAL VIEW

Ankle Sprain

Ottawa Ankle Rules
For Ankle Injury Radiography

An ankle x-ray series is only required if there is any pain in the malleolar zone and any of these findings:
1) Bone tenderness at A
   OR
2) Bone tenderness at B
   OR
3) Inability to bear weight both immediately and in the ED
Ankle Sprain

Rehab

• Phase I
  • Rest and protection (brace, cast, splint, crutches, ice wrap)
  • Control of swelling (compression, elevation
  • Early weight bearing

• Phase II
  • Reduce residual swelling and restore ROM and strength
  • Follow with low impact aerobic training

• Phase III
  • Proprioceptive exercises and sports-specific skills (running, jumping, cutting) with gradual return to sports
  • May wear ankle stabilizing brace or tape ankle to prevent further injury
Ankle Sprain

• If continuing symptoms (uncommon), refer
  • Chronic ankle instability; could be disorder of proprioception, muscle control, and ligamentous stability, or could be incompetent stabilizing ligament
    • May require surgery

• OCD of talar dome
  • May require surgery
General Prevention Strategies

• Don’t start sports until age 6
• Accurate assessment of each child’s readiness
  • A mismatch in skills to sports can result in anxiety, stress and loss of interest in continued participation

General Prevention Strategies

• Pre-participation physical
  • American Academy of Family Practice, American Academy of Pediatrics, American College of Sports Medicine, American Medical Society of Sports Medicine, American Orthopedic Society of Sports Medicine, and American Osteopathic Academy of Sports Medicine
  • Screening tool
  • Identify problems that may require further investigation: heart, lungs, neurologic, etc.
  • Educate athletes on nutrition and unhealthy behavior
General Prevention Strategies

• There may be an underlying problem that predisposes a child to injury, so it is important to fully evaluate the patient before zeroing in on one acute injury
  • Ex: multiple patellar dislocations
    • Ehlers-Danlos syndrome
    • Malignant malalignment
    • Increased tibial tubercle-trochlear groove distance
    • Dysplastic trochlea
    • Patella Alta
    • Increased Q-angle
General Prevention Strategies

• Collaboration
• Parents, coaches, players
• Parents and coaches should not encourage the young athlete to play through pain and should follow sports-specific guidelines
General Prevention Strategies

• Pay special attention to the immature skeleton
  • Appropriate exercise volumes during practice, games, and rehabilitation

• Time off
  • At least 1 day off per week and at least 1 month off per year from training for a particular sport; the body needs to recover

• Proper Equipment
  • Pads (neck, shoulder, elbow, chest, knee, shin)
  • Helmets
  • Mouthpieces
  • Face guards
  • Protective cups
  • Eyewear
General Prevention Strategies

• Strengthen Muscles
• Stretch (after the game)
• Use proper technique
• Pay attention to the temperature
• Drink plenty of fluids

• STOP IF THERE IS PAIN
Remember the Goals…

• Have fun!
• Be active
• Practice fundamental skills
• Learn
Network of 22 Shriners Hospitals for Children

• Network of **22 healthcare facilities** specializing in pediatric orthopedics, burn care, cleft lip & palate and spinal cord injuries.
• Twin Cities hospital specializes in pediatric orthopaedics
• Closest Shriners burn hospital is in Cincinatti
• Spinal cord injuries & cleft lip/palate can be treated in Chicago

Our Mission

• To provide the highest quality medical and surgical care to children with orthopedic needs within a compassionate, family-centered and collaborative care environment.

• To provide the highest quality care **without regard to the ability of a patient or family to pay.**

Accepting Insurance

• Accepting most major insurance carriers, including Medicaid.

• **No insurance? No problem!**
Conditions Treated

Foot and ankle disorders
- Bunions
- Cavus feet
- Club foot / talipes equinovarus (pre-postnatal)
- Congenital foot deformities
- Pes planus (flat feet)
- Tarsal coalition
- Toe walking
- Vertical talus

Hand and toe disorders
- Constricting bands of digits, arms and toes
- Supernumerary digits
- Polydactyly and syndactyly of digits

Hip, knee and leg disorders
- Genu valgum / varum
- Hip dysplasia
- Intoeing
- Legg-Calve-Perthes disease
- Leg length discrepancy
- Osgood-Schlatter disease
- Slipped capital femoral epiphysis
- Trauma reconstruction

Muscular/neuromuscular disorders
- Cerebral palsy/encephalopathy
- Charcot-Marie-Tooth
- Spinal muscular atrophy
- Muscular dystrophy
- Myelodysplasia (spina bifida)
Conditions Treated Continued

Rheumatology
- Dermatomyositis
- Juvenile idiopathic arthritis
- Lupus
- Osteogenesis imperfecta
- Scleroderma

Shoulder disorders
- Erb’s palsy

Special orthopaedic disorders
- Arthrogryposis
- Bone lesions (no oncology)
- Limb deficiency – upper and lower extremity prostheses
- Metabolic bone disease (rickets)

- Skeletal dysplasia

Spinal Disorders
- Congenital spine disorders
- Kyphosis/lordosis
- Scoliosis
- Spondylosis and spondylolisthesis
- Tethered cords

Specialized plastic surgery
- Birthmarks
- Breast reduction
- Ear reconstruction
- Hemangioma
- Burn scar releases (no acute burn care)
Holistic Approach to Care

Camps

P R O M
Services

• Specialty Clinics
• Surgery Services
• Inpatient Care
• Rehabilitation (Occupational & Physical Therapy)
• Orthotics (Bracing) & Prosthetics (Artificial Limbs)
• Radiology (X-Rays)
Referral Guidelines

- Children & adolescents 18 years and younger
- Stabilize at ER/UR and then proceed to a pediatric orthopaedic surgeon for casting, surgery, therapy and follow-up
- Fracture & sports injuries will be seen same day or next day
- Financial assistance available – all children will be treated regardless of ability to pay
- Transportation is available upon request

To Schedule:
Urgent: 612-269-7021
Non-Urgent: 612-596-6105
Fax: 612-596-6102
THANK YOU
References


