The Uniqueness of the Pediatric and Adolescent Athlete

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Introduction

Purpose – to review the unique growth and development characteristics of child and adolescent AES athletes and how these characteristics, in turn, may predispose them to increased risk of injury.
Topics To Be Covered

- Differential growth
- Vulnerability to concussion
- Adolescent growth spurt
- Unique response to skeletal injury
- Age- and maturity-associated variation
- Sport readiness
Differential Growth

- Notice the proportionately large head and short legs of the young child
  - Head: 2X
  - Trunk: 3X
  - Upper Extremity: 4X
  - Lower Extremity: 5X

Changes in Body Proportions with Age
The “top-heavy” child would be at increased risk of falling, head first, in sports which involve climbing or riding on top of animals such as sheep, camels, horses, or on top of ATV’s and off-road motorcycles and bicycles.
Vulnerability to Concussion

- Relative nervous system immaturity along with decreased myelination, a greater head-to-body ratio, and weaker neck muscles may make the young athlete more vulnerable to concussion.

Vulnerability To Concussion

- Children and adolescents also may require a more prolonged recovery from concussion compared to adults.
Adolescent Growth Spurt

Studies show that the adolescent growth spurt appears to be a time of increased risk of injury.

Don Bailey and his co-workers showed an association between peak height velocity and peak fracture rate in children and adolescents.

Adolescent Growth Spurt

Three studies report that during the transition from pre-pubertal to pubertal stages, neuromuscular control of knee motion and landing forces is significantly worse in females than in males, thus predisposing to knee injury.

Unique Response to Skeletal Injury

- Pediatric and adolescent athletes are at risk of incurring unique injuries not seen in adults because of the different structure of growing bone compared to mature bone.

Examples of injuries unique to the young athlete include epiphyseal plate fractures, stress-related epiphyseal plate injury, apophysitis, and apophyseal avulsion fractures.

**Frequency of Sports-Related Epiphyseal Growth Plate Fractures with Associated Growth Disturbance**

<table>
<thead>
<tr>
<th>Case Series Studies</th>
<th>Total no. of growth plate (GP) fractures</th>
<th>Percent of GP fractures associated with organized sport</th>
<th>Percent of sports-related GP fractures associated with growth disturbance</th>
</tr>
</thead>
<tbody>
<tr>
<td>N=25</td>
<td>826</td>
<td>38.3% (n=316)</td>
<td>14.9% (n=47)</td>
</tr>
</tbody>
</table>

# Growing Number of Published Reports on Stress-Related Epiphyseal Plate Injury in Youth Sports

<table>
<thead>
<tr>
<th>Sport</th>
<th>Anatomical Location(s)</th>
<th>Epiphyseal stress injury</th>
<th>Growth Disturbance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Badminton</td>
<td>Proximal humerus</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Baseball</td>
<td>Proximal humerus</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Basketball</td>
<td>Distal femur, proximal tibia</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Climbing</td>
<td>Middle phalanx</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Cricket</td>
<td>Proximal humerus</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Football</td>
<td>Distal femur, proximal tibia</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Gymnastics</td>
<td>Proximal humerus, clavicle, distal radius</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Rugby</td>
<td>Distal femur, proximal tibia</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Running</td>
<td>Proximal tibia, first metatarsus</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Soccer</td>
<td>Distal tibia/fibula</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Swimming</td>
<td>Proximal humerus</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Tennis</td>
<td>Proximal tibia</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Volleyball</td>
<td>Proximal humerus</td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>

Nine-Year Study: 14 of 28 top-level Chinese gymnasts training 60 hours per week developed progressive wrist pathology

<table>
<thead>
<tr>
<th>Clinical Characteristics</th>
<th>Radiographic Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stage I</strong></td>
<td></td>
</tr>
<tr>
<td>Wrist pain associated with upper extremity weight-bearing</td>
<td>No abnormalities seen</td>
</tr>
<tr>
<td><strong>Stage II</strong></td>
<td></td>
</tr>
<tr>
<td>Decreased range of motion at the wrist</td>
<td>Stress-related changes of the distal radial growth plate</td>
</tr>
<tr>
<td><strong>Stage III</strong></td>
<td></td>
</tr>
<tr>
<td>Wrist function is limited</td>
<td>A relatively lengthened ulna; wrist joint presents with arthritic changes</td>
</tr>
</tbody>
</table>


Age- and Maturity-Associated Variation

- When children and adolescents are grouped by age, variation is associated with chronological age per se and also with differences in biological maturity which may relate to increased risk of injury.
Age- and Maturity-Associated Variation

Because young athletes of the same age can differ greatly in size and physical maturity, some, less mature individuals, may try to perform at levels beyond their ability to keep up with their peers.
Sport Readiness

Do the child’s cognitive, psychosocial and motor abilities enable him/her to safely meet the demands of a given sport?

Sport Readiness: A Developmental Perspective

Some argue, for example, that "because children often lack the cognitive abilities to operative ATV’s and other off-road vehicles properly that their risk for injury may be greater."

Sport Readiness: A Developmental Model

- Others argue that children ≤ 12 years do not have adequate physical size and strength to control an ATV; therefore, their risk of injury may be greater.

- American Academy of Orthopedic Surgeons, 2013
Sport Readiness: A Developmental Perspective

The CDC stresses that underdeveloped coordination and motor skills may also relate to an increased risk of childhood injury.

Children might also be at increased risk of injury because of reduced emotional maturity and judgement compared to adults, especially in the presence of peers.

In Summary...

- Children and youth may be particularly vulnerable to AES injury due to such factors as:
  - Differential growth
  - Vulnerability to concussion
  - Adolescent growth spurt
  - Unique response to skeletal injury
  - Age- and maturity-associated variation, and
  - Sport readiness
Although problems do not ordinarily arise at normal levels of activity, the training and performance demands of AES today may create conditions under which these potential growth- and maturation-related risk factors exert their influence.
Summary Comments

A Parting Thought!

Do the characteristics and demands of some AES, regardless of modifications, require a level of development – motor, cognitive, psychosocial – which may be unavailable to some young children?