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Application of MRI of the Wrist for Age Determination in International U-17 Soccer Competitions

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Under 17, Football Competition, Age Determination, MRI

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Abstract

Background: In order to guarantee equal chances for different age groups, age-related tournaments for male and female players have been established in soccer. However, while registration at birth is not compulsory in some countries, other methods of age determination are needed to prevent participation in the incorrect age group.

Objectives: To evaluate the age of soccer players of international U-17 competitions based on the degree of fusion of the distal radius and to compare the findings with an age-related normative population.

Methods: MRIs of the wrist of a representative sample of 189 players from four U-17 competitions (FIFA U-17 World Cups 2003 and 2005, Asian (AFC) U-17 championships 2004, 2006) were analysed using a previously published grading system.

Results: Due to different regulations, all players in AFC U-17 championships were younger than 17 years, whereas 71% of the players in FIFA U-17 World Cups were 17 years old. The distal radius of 15% of players from the AFC U-17 and 27% of the players from the FIFA U-17 tournaments were graded completely fused on MR images which is a substantially higher percentage than in the respective age groups of a previously published normative population of soccer players. Furthermore, in contrast to the normative population no significant correlation between the age category and the grading of fusion (rho=.13, n.s.) was observed in U-17 players.

Conclusion: Following the results of MRI investigation, U-17 players seem to be more mature than a normative population of the same age category. However, the lack of correlation between age category and degree of fusion in U-17 players supports the suspect that the age stated in the official documents of the examined U-17 players might not be correct in all cases.
INTRODUCTION

In most sports, the performance of adolescent athletes is determined by their physical maturity and thus related to age. Malina examined maturity-associated variation in sport-specific skills of youth soccer players concluding that age, experience, body size and stage of puberty contribute significantly in different combinations to the variance of some soccer skills such as dribbling with a pass, ball control with the body and shooting accuracy.\(^2\) Also players with a greater relative (or possibly false lower) age are more likely to be identified as “talented” because of the likely physical advantages they have over their “younger” peers.\(^3\) In order to guarantee equal chances for different age groups, age-related tournaments for male and female players have been established in soccer. However, due to the fact that registration at birth is not compulsory in some African and Asian countries, other methods of age determination are needed to prevent participation in the incorrect age group.

Standard radiographs of the left wrist for assessment of skeletal age has been described by Todd, and Greulich & Pyle\(^4,5\), Tanner\(^6,7\) and earlier using the Fels Method\(^8\) which is still widely used for assessment of skeletal age. While standard radiographs with attendant radiation risks cannot be justified as the screening tool for soccer populations, age estimation based on grading of fusion of the distal radius using MRI has recently been shown to be a reliable and valid method in 14 to 19 year old soccer players\(^1\).

In a previous study\(^1\) 496 healthy male adolescent soccer players between the ages of 14 and 19 from Switzerland, Malaysia, Algeria, and Argentina had a MR examination of the left wrist, and a newly developed grading system was applied for determining the degree of epiphyseal fusion of the radius. The inter-rater reliability for grading was high. The average age increased with a higher grading of fusion and the correlation between age and grade of fusion was highly significant. Only one player (0.77\%) of the 16-year-old age group was graded as completely fused and therefore mature. The authors\(^1\) concluded that MRI of the wrist offers an alternative as a non-invasive method for age determination of male adolescents, and the grading system identified the skeletal maturity by complete fusion in all MRI slices which eliminates the radiation risk associated with standard radiographs.

Aims of the study

- To evaluate the age of a representative sample of soccer players from international U-17 competitions (Fédération Internationale de Football Association – FIFA and Asian Football Confederation - AFC) using MRIs of the wrist
- To compare the MRI findings of the players of U-17 competitions with an age-related normal population.

METHODS

Players from four U-17 competitions (2003 FIFA U-17 World Cup in Finland, 2004 AFC U-17 championship in Japan, 2005 FIFA U-17 World Cup in Peru, 2006 AFC U-17 championship in Singapore) were included in the study.

The MRIs were collected in the respective countries of the tournaments according to the parameters which have previously been used to determine normative values (1.0 or 1.5 Tesla magnet, dedicated wrist coil, coronal T1-weighted spin-echo images)\(^1\). The MRIs were stored,
where possible, electronically in the DICOM format, in order to allow evaluation electronically on a picture archiving and communication system (PACS).

The degree of fusion of the distal radius was graded independently by three raters using a previously published grading system \(^1\) (see Table 1).

**Table 1:** Classification criteria for ossification/fusion of the distal radius on MR images \(^1\)

<table>
<thead>
<tr>
<th>CLASSIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Completely unfused</td>
</tr>
<tr>
<td>II. Early fusion: minimal hyperintensity within physis</td>
</tr>
<tr>
<td>III. Trabecular fusion of less than 50% of radial cross-sectional area</td>
</tr>
<tr>
<td>IV. Trabecular fusion of more than 50% of radial cross-sectional area</td>
</tr>
<tr>
<td>V. Residual physis, less than 5 mm on any one section</td>
</tr>
<tr>
<td>VI. Completely fused</td>
</tr>
</tbody>
</table>

The raters (three of the four authors) were blinded with regard to the name, age, and country of the players as well as to the country of competition. Two raters were experienced radiologists and one an experienced neurologist with extensive experience in imaging. The blinding code was prepared by the fourth author (epidemiologist). The three individual gradings were computed to a majority grading using the most frequent grading or if all three ratings deviated the average grading.

**Population**
In both FIFA and the first ACF U-17 competitions (2003 FIFA U-17 World Cup in Finland, 2004 AFC U-17 championship in Japan, 2005 FIFA U-17 World Cup in Peru) three players from each of the 16 participating teams were randomly selected for examination.

In the 2006 AFC U-17 championship, a specially trained AFC physician selected three players from each of the 16 teams based upon the anthropometric data (height, BMI). With this approach the AFC competition department aimed to select the most maturely appearing players in each team. Prior this tournament AFC had advised the team managers that MRI would be performed to detect players with complete fusion of the distal radius and proposed that each country should do its own screening before registering players for participation.

**Statistical analysis**
All data was processed on a Macintosh computer (Apple Computer, Cupertino, California) using Microsoft Excel (Microsoft Corp., Redmond, Washington). The statistical procedures were performed using StatView (version 5.0; SAS Institute, Cary, North Carolina). Statistical methods applied were frequencies, cross-tabulations and Spearman’s (Rho) Rank Correlation.

**RESULTS**
In total 189 players were examined during the four U-17 competitions; 48 players from each the 2003 FIFA U-17 World Cup in Finland, the 2004 AFC U-17 championship in Japan, the 2006 AFC U-17 championship in Singapore, and 45 players from the 2005 FIFA U-17 World
Cup in Peru. In the latter competition three players of one team could not be examined due to logistic and technical reasons.

The distribution of the players’ age in the AFC and FIFA competition is displayed in Figure 1. In the AFC competitions all players were under 17 years old according to their documents, whereas in the FIFA competitions 71% (n= 66) were 17 years old.

Table 2 represents the distribution of the degree of fusion in the four U-17 tournaments and age-related values from a normative population. A total of 14 players (15%) presented complete fusion of the distal radius (Grade VI) for the AFC competition, while in the FIFA competition 25 players (27%) with complete fusion of the distal radius were observed. The respective values of the normative population were less than 1% of under 17 year old players, and 10% of 17 year old players. For the AFC as well as for the FIFA U-17 tournaments the rate of completely fused players decreased from the first to the second competition under investigation (FIFA: from 2003 to 2005; AFC: from 2004 to 2006). However, in all four U-17 competitions more players had the two highest degrees of fusion (Grade V and VI) than in the age-related normative population (AFC: 48% vs 14%; FIFA: 61% vs 37%).

Table 2: Distribution of the grading of fusion in the four U-17 competitions and in the different age groups of a normative population

<table>
<thead>
<tr>
<th>Grade of fusion</th>
<th>FIFA U-17 Finland 2003</th>
<th>FIFA U-17 Peru 2005</th>
<th>AFC U-17 Japan 2004</th>
<th>AFC U-17 Singapore 2006</th>
<th>norm 16-17 year old1</th>
<th>norm 17-18 year old1</th>
<th>norm 18-19 year old1</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>7 (15%)</td>
<td>0</td>
<td>3 (6%)</td>
<td>0</td>
<td>16 (12.3%)</td>
<td>5 (4.3%)</td>
<td>0</td>
</tr>
<tr>
<td>II</td>
<td>11 (23%)</td>
<td>4 (9%)</td>
<td>11 (23%)</td>
<td>5 (10%)</td>
<td>65 (50.0%)</td>
<td>37 (32.2%)</td>
<td>5 (5.9%)</td>
</tr>
<tr>
<td>III</td>
<td>3 (6%)</td>
<td>5 (11%)</td>
<td>4 (8%)</td>
<td>6 (13%)</td>
<td>16 (12.3%)</td>
<td>10 (8.7%)</td>
<td>8 (9.4%)</td>
</tr>
<tr>
<td>IV</td>
<td>2 (4%)</td>
<td>4 (9%)</td>
<td>9 (19%)</td>
<td>15 (31%)</td>
<td>15 (11.5%)</td>
<td>21 (18.3%)</td>
<td>13 (15.3%)</td>
</tr>
<tr>
<td>V</td>
<td>8 (17%)</td>
<td>24 (53%)</td>
<td>10 (21%)</td>
<td>19 (40%)</td>
<td>17 (13.1%)</td>
<td>31 (27.0%)</td>
<td>49 (57.6%)</td>
</tr>
<tr>
<td>VI</td>
<td>17 (35%)</td>
<td>8 (18%)</td>
<td>11 (23%)</td>
<td>3 (6%)</td>
<td>1 (0.8%)</td>
<td>11 (9.6%)</td>
<td>10 (11.8%)</td>
</tr>
<tr>
<td>Total</td>
<td>48</td>
<td>45</td>
<td>48</td>
<td>48</td>
<td>130</td>
<td>115</td>
<td>85</td>
</tr>
</tbody>
</table>

Figure 2 displays the distribution of grades of fusion in different age groups for players of the U-17 competitions and the normative population. Eight players of the AFC U-17 championships were 14 years according to their documents; in three cases the fusion of the distal radius were graded VI and in two cases graded V. In contrast, no case of the normative population aged 14 years was graded IV, V, or VI, and only 5% (6 of 125) of the 15 year old were graded V. In twelve of 27 (44%) 15 year old U-17 players, fusion of the distal radius was graded V or VI, whereas this applied for only 5% of the 15 year old normative population. In U-17 players, the gradings of fusion increased only slightly from the 15 to the 16 year old players and from the 16 to the 17 year old players. Furthermore, in contrast to the normative values, no significant correlation was observed between the age category and the grading of fusion (rho=.13, n.s.).
DISCUSSION

The present study evaluated the age of a representative sample of 189 players of four international U-17 soccer tournaments using MRIs of the distal radius and the official documents. Two FIFA and two AFC U-17 tournaments were included in the study because of the different definition of U-17 tournaments in the regulation of AFC and FIFA. The regulation of AFC clearly indicates that for the U-17 competition all players have to be younger than 17 years, according to the documents, at the start of the competition. While for FIFA U-17 competitions, the players must have been born on 1st January and/or later 17 years prior the year of the tournament, for example 1st January 1998 and/or later for the competition in August 2005 in Peru. Thus, players of FIFA U-17 World Cups can be 17 years at the start of the championship, and this applied for 71% of the players of both FIFA U-17 World Cups included in the present study. In contrast, in the AFC championships 66% of the players included in the present study were 16 years old and 34% even younger. It can therefore be summaries that the AFC competition is a true U-17 championship while the FIFA tournament is actually an U-18 competition.

The MR images of 27% of the players from the FIFA U-17 and 15% of players from the AFC tournaments were graded VI (completely fused) which is a substantially higher percentage than in the respective age groups of the normative population.1 Comparing the four tournaments, the highest frequency of players with complete fusion of the distal radius (35%) were observed in the FIFA U-17 World Cup 2003 in Finland, and the lowest percentage (6%) in the AFC championship 2006 in Singapore where the assessment of MR images were announced prior to the competition and the players were pre-selected. However, for both types of tournaments (AFC and FIFA) a drop in the rate of completely fused players was observed between the first and the second competition under investigation (FIFA: from 2003 to 2005; AFC: from 2004 to 2006). It can be only hypothesised that this decrease is due to the fact that the team managers were aware of controls were going to be carried out and a more careful selection was carried out.

If U-17 players were categorised in age-groups according to their official documents, a higher degree of fusion was observed in all groups compared to the age-related values of a normative population of soccer players.1 Following the results of MRI investigation U-17 players seem to be more mature than a normative population of soccer players. However, in contrast to the normative population no correlation was observed between the age category and the grading of fusion. This mismatch between the age stated in the official documents and the biological maturity by means of fusion of the distal radius in some U-17 players cannot be clearly explained, but it supports the suspicion that some U-17 players are older than stated in their official documents. In consideration of the biological variability, an estimation of “true” age of an individual can only be made with a certain probability, however for a group of individuals MRI of the wrist has been shown to be a reliable and valid method for age estimation in 14 to 19 year old soccer players.1

CONCLUSION

MRI investigation of bony fusion of the left distal radius is a viable tool for screening of football players in the youth competition to estimate the age and degree of maturity, particularly in the groups U-16 and U-17. Based on the results of the MRI examination of the left radius the officially stated ages of U-17 players might not be correct in all cases.
What is already known on this topic?
In order to guarantee equal chances for different age groups, age-related tournaments for male and female players have been established in soccer. However, while registration at birth is not compulsory in some countries, other methods of age determination are needed to prevent participation in the incorrect age group. Grading of fusion of the distal radius based on MRI assessment is a reliable and valid method for age estimation in 14 to 19 year old soccer players.

What this study adds?
MRI investigation of fusion of the left distal radius is a viable tool for screening to estimate the age and degree of maturity of players in U-17 soccer competitions. U-17 players seem to be more mature than a normative population of the same age-category. However, in contrast to the normative population no correlation was observed between age category and degree of fusion. This lack of correlation in U-17 players supports the suspect that the age stated in the official documents of the examined U-17 players might not be correct in all cases.

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Figure 1: Age distribution of players in the FIFA and AFC U-17 competitions.
Figure 2: The distribution of age related grades of fusion development of the distal radius of left hand U-17 players and a normative population.
References