Bone Age Determination in Girls with Early Puberty and Limitations of Adult Height Prediction: Can automated evaluation (BoneXpert™) be a solution?

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Introduction

- One of the factors affecting the treatment decision in early puberty is bone age (BA) evaluation and adult height prediction (AHP), accordingly. These calculations have certain limitations. In this study, we aimed to compare the AHP results calculated by Bayley-Pinneau (BP) and Roche-Wainer-Thissen(RWT) methods based on BA evaluation by using Greulich-Pyle(GP) atlas and BoneXpert™ software.

- Greulich-Pyle (GP) (1959)
- Tanner-Whitehouse (TW) (1962)
- BoneXpert (2008)

GP TW

Assesment of Radius, ulna ve short bones at the 1st-3rd and 5th raw (total 13 bones, RUS system)

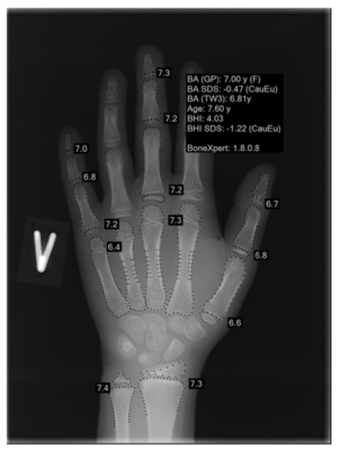

Fig 1. Hand radiograph analyzed using BoneXpert. Bone age using both Greulich and Pyle as well as Tanner Whitehouse are calculated. Additionally the bone health index is calculated

Methods

- A total of 77 girls (6.1-10.8 years of age) who presented with early puberty suspicion between June 2016 and November 2018, were included in the study.
- At the time of presentation, BA was determined by a pediatric endocrinologist by using GP bone age atlas (Standard BA). The same X-rays were also analyzed by BoneXpert software program and bone age was determined by GP (BXpertBA-GP) and TW (BXpertBA-TW) methods.
- Adult height prediction was calculated by using a national online program named ÇEDD-ÇÖZÜM.
- Three BA evaluations and two AHP methods (BP and RWT) were used to calculate predicted adult heights (PAH) of participants, thereby 6 different predictions were made (PAH_1: BP method with standardBA-GP, PAH_2: RWT method with standardBA-GP, PAH_3: BP method with BxpertBA-GP, PAH_4: RWT method with BA-GP, PAH_5: BP method with BxpertBA-TW, PAH_6: RWT method with BxpertBA-TW)

Results

The mean age of the participants was 8.7 years, while the mean standard BA was 9.98 years, the mean BXpertBA-GP was 9.87 and the mean BXpertBA-TW was 9.51 years. There was no significant difference between the mean standard BA and BXpert BA-GP. However, BXpert BA-TW was significantly lower than the other two BAs ($p < 0.001$). The mean actual height of the participants was 136 cm while median height SDS was 1.01. The mean PAH_1 was similar to PAH_3(161.3 vs 162.2 cm), however PAH_1 was significantly lower than PAH_2 (162.6 cm), PAH_4(162.5 cm), PAH_5(164.3 cm), PAH_6(163.5 cm) ($p<0.008$)(table1). The mean PAH_1 was significantly lower than mean mid-parental height of the participants 161.3 vs 163.3 cm, $p<0.007$).

Table 1. Adult height prediction with different methods

Midparental height (cm)	163.3±4.9 (153.5-176)
Midparental height SD	0.07 (range -1.6-2.2)
PAH_1 (stdBA-BP)	161.3±6.1 (148.9-178.1)
PAH_2 (stdBA-RWT)	162.6±4.3 (150.3-175.8)
PAH_3 (BxBA-GP-BP)	162.2 ±5.6 (147.1-174.2)
PAH_4 (BxBA-GP-RWT)	162.5±4.6 8146.6-174.7)
PAH_5 (BxBA-TW-BP)	164.3±6 (150.6-177.8)
PAH_6 (BxBA-TW-RWT)	163.5±4.2 (151.3-175.1)

- *Significant difference between MPH and PAH_5 (BxKY-TW-BP) ($p=0.004$)*
- *PAH_1 (stdKY-BP) and PAH_3 (BxKY-GP-BP) are similar ($p=0.026$) , however significantly lower than the others ($p<0.008$).*

Table 2. Comparison of the different PAH- Z scores

	PAH_1 (stdBA-BP)	PAH_2 (stdBA-RWT)	PAH_3 (BxBA-GP-BP)	PAH_4 (BxBA-GP-RWT)	PAH_5 (BxBA-TW-BP)	PAH_6 (BxBA-TW-RWT)	p
Z SKORU	-0.3 (-2.2-2.9)	-0.2 (-2-1.9)	-0.06 (-2-1.7)	-0.08 (-1.9-1.7)	0.04 (-1.9-2.2)	-0.03 (-1.8-1.8)	<0.05

- *PAH_1SDS <PAH_4, PAH_5, PAH_6 SDS ($p<0.008$)*
- *PAH_2 SDS <PAH_5, PAH_6 SDS ($p<0.008$)*
- *PAH_3 SDS < PAH_5, PAH_6 SDS ($p<0.008$)*
- *PAH_4 SDS <PAH_5, PAH_6 SDS ($p<0.008$)*

Conclusions

The PAH which was calculated by the most commonly used BP method based on Standard BA-GP is the lowest, however it is impossible to determine which method is most accurate untill the participants achieve their final heights. We think that, it would be more reasonable to take a range rather than only one result for PAH into consideration before making a decision on treatment.