The angle of trunk rotation in children with growth hormone deficiency

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Abstract

Background. Growth hormone plays a vital role in the human body. Its deficiency can lead to numerous disorders, including musculoskeletal system defects. Treatment with recombinant human growth hormone (rhGH) in children suffering from growth hormone deficiency (GHD) increases muscle mass and improves bone structure.

Aim. The purpose of this study was to evaluate the angle of trunk rotation (ATR) in patients diagnosed with GHD treated with rhGH and to observe the incidence of scoliosis.

Material and Methods. The study was conducted among 50 children diagnosed with GHD. The group consisted of 11 girls and 39 boys aged 6-16. The study group included 50 children: 10 children just qualified for rhGH treatment and 40 patients undergoing this treatment, with different therapy duration. ATR was measured using a Bunnell scoliometer on five levels of the spine: cervical 7 / thoracic 1, thoracic 6, thoracic 12 / lumbar 1, lumbar 3, lumbar 5 / sacral 1.

Results. The most numerous asymmetries among the examined group were in the thoracolumbar segment and at the thoracic 6 level. Girls had greater asymmetries compared to boys especially at thoraco – lumbar and lumbar 3 level. There were no statistically significant differences in ATR at any level comparing patients before hormonal treatment and patients undergoing rhGH treatment. The age of the beginning of the therapy, the duration of rhGH therapy, and body mass index (BMI) also had no effect on ATR. Sport activities had a positive impact on the results obtained by scoliometer assessment.

Conclusions. The angle of trunk rotation is higher in growth hormone-deficient females than in males. Weight, height, BMI, the time of growth hormone therapy beginning and the duration of this therapy do not influence ATR. The more sport activities, the lower value of the angle of trunk rotation, especially in male patients. Obtained results support the thesis, that

treatment with recombinant human growth hormone does not increase the incidence of scoliosis.

Key words: scoliosis, growth hormone deficiency, Bunnell scoliometer, recombinant human growth hormone

Background

Growth hormone affects the composition of the human body. People with growth hormone deficiency (GHD) present an increased body fat mass, while a reduced lean body mass, including muscle mass [1]. The increase in muscle mass and bone structure improvement is observed, during the use of recombinant human growth hormone therapy (rhGH), which increases the patient's quality of life [2]. Thus, growth hormone plays a vital role in the composition and function of the body. It affects the skeletal system, stimulates bone growth and skeletal mineralization [3], stimulates protein metabolism by the anabolic effect on skeletal muscles [4]. It also affects fat metabolism by stimulating lipolysis and reducing the percentage of fat in body composition [5]. Growth hormone is also involved in carbohydrate metabolism [5] and water-electrolyte balance [6].

Growth hormone therapy may be associated with some side effects in children [7-10]. Several studies indicated that rhGH treatment might contribute to the worsening of scoliosis due to rapid, accelerated growth in short time [11-15]. However, another study showed that the incidence of scoliosis in children treated with rhGH is similar to the prevalence of idiopathic scoliosis in the general population [16]. Whether growth hormone therapy may cause the risk of scoliosis is still discussed. Analysis of the literature does not show precisely whether the recombinant growth hormone is a risk factor for the occurrence of scoliosis.

The purpose of this study was to observe the incidence of scoliosis in patients diagnosed with growth hormone deficiency and treated with rhGH and to evaluate the angle of trunk rotation.

The next stage of the research will be the reassessment of the patients after 1.5 years of rhGH treatment with the analysis of the changes that may appear in body posture.

Material and methods

The study was approved by the Local Ethics Committee of the University of Medical Sciences (consent ref. no. 1107/17, 9 November 2017), and written consent was obtained before the procedure from all the parents or legal guardians.

Characteristics of the study group

The study involved 50 children with short stature due to growth hormone deficiency. The group consisted of 11 girls and 39 boys, aged 6-16. The study group included 10 children just qualified for the rhGH treatment and 40 patients undergoing this treatment, with different therapy durations. Data describing the group are presented in Table 1. The examination of the body posture was performed by the same person, master degree in physiotherapy, who completed specialized, international courses in diagnosing posture defects including scoliosis and having professional experience in working with patients.

Children diagnosed with GHD were qualified for the study. Patients with neurological deficits, genetic defects, orthopedic diseases or after invasive surgery, as well as patients with traumatic perinatal history were excluded.

Table 1 presents the characteristics of the group without age division and by gender, taking into account the average values of such parameters as: body weight, height, BMI, the age of starting treatment with recombinant growth hormone, duration of treatment, number of hours per week spent on sports.

The research

At the beginning, the parent / legal guardian was asked to complete a questionnaire in which personal data had to be provided, perinatal interview completed, and it also included information regarding the number of hours spent in sport activities, the child's current state of health, such as chronic diseases, previous operations, vision or hearing defects.

Weight and height were measured using a weighted medical height meter (Radwag 2006). Height measurement was made with an accuracy of 0.1 cm and body weight measurement up to 0.01 kg.

The angle of trunk rotation was measured using a Bunnell scoliometer. This simple tool allows to make objective measurements quickly and simply [17-19]. This device is made of plastic, inside it has a tube filled with liquid in which the indicator moves, similar to a level. The graduated scale makes it possible to read the angle of trunk rotation. In the middle of the lower edge of the scoliometer there is a depression, which is placed in the level of the spinous process of the vertebra.

The spine was assessed in the transverse plane in a free-standing position, without shoes. The lower limbs were straight at the knee joints, and the feet were placed the width of the hips apart. During the examination, the patient bent forward the trunk. The scoliometer was placed perpendicular to the long axis of the spine. The scoliometer was placed on the trunk without pressure [18,20]. When the spine is symmetric, the scoliometer indicates a value of 0 degrees. The angle of trunk rotation can be measured at the largest asymmetry sphere of the spine, or at different levels of the spine, which are, for example, the most common location for scoliosis [21]. For the purposes of the study, each patient was measured at five levels: C7 / Th1, Th6, Th12 / L1, L3, L5 / S1 according to the recommendations of the Functional

Individual Therapy of Scoliosis (FITS) method. A scoliometer is a reliable tool for measuring vertebral rotation [22] which is recommended for scoliosis screening.

The following ranges of ATR were included:

0-3 degrees - physiological asymmetry of the torso

4-6 degrees – necessity to repeat the test after 3-4 months

> 7 degrees – may suggest scoliosis, X-ray is recommended and the visit in orthopaedist [23].

Statistical analysis was performed using the statistical package Statistica 10 PL. The Mann–Whitney U-test was used to determine the difference in the angle trunk rotation in C7, Th6, Th12 / L1, L3 and L5 / S1 levels. Correlations between variables were determined by the significance test of Spearman's rank correlation coefficient. A p-value < 0.05 was considered statistically significant.

Results

Children angle trunk rotation was measured by Bunnel scoliometer at C7 / TH1, Th6, Th12 / L1, L3, L5 / S1. The results are presented in Table 2. Only one girl had ATR above 7 degrees at the thoracolumbar level. All children presented norm in the level of axial region of the cervical spine referring (ATR between 0 – 3 degrees). The minority of the children presented ATR between 4 and 6, especially in thoracolumbar and Th6 level which meant that they needed repetition of the examination between 3 – 4 months.

Table 3 shows the number of all patients at the beginning of rhGH therapy, which presents a specific range of rotation angle measured at C7/TH1, Th6, Th12 / L1, L3, L5 / S1.

Table 4 presents the average and mean value of angle trunk rotation at the five examined levels of the spine: C7/TH1, Th6, Th15 / L5, L3 and L5 / S1.

There were statistically significant differences in the ATR between girls and boys at Th12 / L1 ($p = 0.0238$). The girls presented greater ATR comparing to boys (3.36 ± 2.11 ° and 1.90 ± 1.60 °, respectively). The same difference was noted at the L3 level ($p = 0.0130$) – ATR value at L3 was higher in girls than in boys (3.09 ± 1.38 ° and 1.74 ± 1.63 °, respectively) (Table 5). The obtained results are presented in Figure 1 and Figure 2.

There were no statistically significant differences in the level of ATR between patients before and during treatment: C7/Th1, Th6, Th12 / L1, L3 and L5 / S1 ($p> 0.05$). No such differences were found after the analysis of the study group by gender either (Table 6).

There are no statistically significant correlations between body weight, height and BMI and ATR ($p> 0.05$). No such differences were found after the analysis of the study group by gender either (Table 7).

There are no statistically significant correlations ($p > 0.05$) between the growth hormone treatment duration and the angles at C7/TH1, Th6, Th12 / L1, L3 and L5 / S1 in patients. No such differences were found after the analysis of the study group by gender either (Table 8).

There are no statistically significant correlations ($p> 0.05$) between the age at the beginning of growth hormone therapy and angle of trunk rotation at C7-Th1, Th6, Th12 / L1, L3 and L5 / S1. No such differences were found after the analysis of the study group by gender either (Table 9).

After analyzing the data, it turned out that sport activities affect body posture. In boys, significant correlations occurred between the number of hours per week spent on sports and ATR at Th6 and Th12 / L1– a negative correlation. The more hours boys spent on sports, the smaller was the ATR at Th6 and Th12 / L1. There was no such relationship in the female group. Perhaps this is due to the small number of girls in the study group. In addition, the average number of hours per week spent on sports was higher for boys than for girls. However, this difference was not statistically significant.

Discussion

The study presents, for the first time, the measurement of the angle of trunk rotation in children with diagnosed GHD. The measurement was performed at five levels: C7/Th1, Th6, Th12 / L1, L3, L5 / S1. It was noted that in 10% of patients, ATR at Th6 level is in the range of 4-6 degrees, the same values: at Th12 / L1 level 10% of children presented abnormalities in the range of 4-6 degrees, at L3 level 8% of patients, while at L5 / S1 level 5% of respondents. One person in the analyzed group (2%) presented ATR above 7 degrees at the Th12 / L1 level – this result suggests scoliosis and requires further therapeutic approach. Other levels tested in the research group remained within normal range (0-3 degrees). According to interviews with parents, no one reported scoliosis either.

It is estimated that idiopathic scoliosis occurs in about 4% of healthy children. It seems that the treatment with recombinant growth hormone does not increase the incidence of scoliosis, but may affect its progression [24-25]. However, the present study did not show the progression of scoliosis during GHD. There was no correlation between the time of growth hormone treatment beginning and the value of the angle of trunk rotation. Perhaps the reason was a small group of examined children and the presence of posture control by doctors and physiotherapists in the examined group. The authors plan to control body posture in the examined patients in order to monitor if the ATR progress.

Available publications show that patients with Turner's syndrome (Ts) who also suffer from short stature are particularly at risk for scoliosis [26]. The National Cooperative Growth Study (NCGS) conducted a study on patients with Turner's syndrome on the safety of using recombinant growth hormone therapy and found that scoliosis was more common in growth hormone-treated patients compared to other patients without Ts [27]. Other authors examined 43 girls with Turner's syndrome and found scoliosis in 11.6% of the girls. Which is definitely a higher frequency compared to a healthy population [28-29]. Patients suffering from Prader-Willi syndrome are also at increased risk of scoliosis [30-32].

Yun and co-authors conducted observations to investigate the effect of recombinant growth hormone therapy on the spine. The study group consisted of patients with idiopathic short stature, while the control group consisted of patients with idiopathic scoliosis. Using the X-ray image, among others, Cobb angle. An annual increase in the angle of 1 degree was observed in patients from the study group, while in the control group, no significant changes were noted during the year. Girls showed a larger Cobb angle compared to boys. Studies showed that growth hormone therapy in patients with idiopathic short stature might affect the progression of Cobb's angle. It should be a broadened procedure to control posture as an important element of typical examination in patients undergoing rhGH treatment [11].

In the study group, a higher ATR was noted in girls compared to boys. A similar relationship is described by Yun et al. [11].

The gender may influence the appearance of scoliosis, as researches from Poland also showed. There is an interdependence between the concentration of oestradiol and the development of scoliosis [33-34]. These showed the coincidence of scoliosis in the female population in general.

There were no statistically significant differences in ATR between patients before treatment and patients during the treatment: C7-Th1, Th6, Th12 / L1, L3 and L5 / S1. According to data analysis, also the age at the beginning of growth hormone treatment did not affect the size of the ATR measured in patients. The literature shows that the growth rate can influence the progress of scoliosis [35].

There are also no statistically significant correlations between body weight, height and BMI and angles at C7/Th1, Th6, Th12 / L1, L3 and L5 / S5. Similar relationships regarding the occurrence of scoliosis and the BMI were observed by Wilczyński [36]. Comparable results showed also Kaźmierczak [37].

The authors showed the relationship between number of hours per week spent on sports and ATR values, especially in the male group. The more time boys devoted to sport, the smaller values of ATR in the thoracic and lumbar-thoracic levels were observed. It seems advisable to promote physical activity in children with GHD treated with rhGH, as it is in some other health disorders during childchood [38-39].

There is a need to control body posture in short stature patients treated with rhGH and also in the general population [40]. We plan to re-examine the angle of trunk rotation among our study group after 1.5 years of growth hormone therapy to analyze the changes in body posture together with anterior-posterior spinal curvatures [41].

Conclusions

The angle of trunk rotation is higher in growth hormone-deficient females than in males. Weight, height, and BMI do not influence the angle trunk rotation in children with GHD. It also does not depend on the time of growth hormone therapy beginning and the duration of this therapy. The more sport activities, the lower the angle of trunk rotation is, especially in boys. It seems advisable to promote physical activity in this group of patients.

Obtained results support the thesis, that treatment with recombinant human growth hormone does not increase the incidence of scoliosis. Still, it is necessary to re-examine the same patients after long-term growth hormone therapy to clearly verify whether this treatment causes changes in the angle of trunk rotation.

List of abbreviations:

rhGH - recombinant human growth hormone

GHD - growth hormone deficiency

ATR - the angle of trunk rotation

BMI - body mass index

cm - centimetre

kg - kilogram

C7 – seventh cervical vertebra

Th1 – first thoracic vertebra

Th6 – seventh thoracic vertebra

Th12 – twelfth thoracic vertebra

L1 - first lumbar vertebra

L3 – third lumbar vertebra

L5 –fifth lumbar vertebra

S1 – first sacral vertebra

FITS - the Functional Individual Therapy of Scoliosis

Ts - Turner’s syndrome

NCGS - National Cooperative Growth Study

SD – standard deviation

m - meter

h – height

n- number

min – minimum

max – maximum

U - Mann-Whitney U test statistic value

p - probability level

Rs - Spearman's rank correlation coefficient for the number n

t - value of t statistics checking the significance of the Rs coefficient for the number of degrees of freedom n-2

Declarations:

- Ethics approval and consent to participate

The research was based on the consent of the Bioethical Commission at the Poznań University of Medical Science, number 1107/17 dated 9th November 2017 year.

Written consent agreement was obtained before the procedure from parents or legal guardians. That informed written consent has been obtained should be clearly stated in the Ethics Approval and Consent to Participate statement.

All children have given the consent for the research.

- Consent for publication

Not appicable

- Availability of data and material

The datasets used and analysed during the current study are available from the corresponding author on reasonable request.

- Competing interests

We have no conflict of interest to declare.

- Funding

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- Authors' contributions

KM research concept and design, performed studies of body posture of children.

MR analyzed and interpreted the patients data. MR tanslated the manuscript into English.

MR and MK drafting the article.

KM, MR, MK prepared munuscript.

SW critical revision of the article.

KA revision and final approval.

KA and SW prepared references and they constitute substantive supervision.

All authors read and approved the final manuscript.

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