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Growth and nutrition of children with chronic renal failure

Constantinos J. Stefanidis

Head of Nephrology, "P. & A. Kyriakou" Children's Hospital, Athens, Greece

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It has long been recognized that chronic renal failure (CRF) in children is associated with growth delay. Still In our days nevertheless, growth retardation remains today a major impediment to the full rehabilitation of children with CRF. The reduction of in height velocity frequently results in diminished final adult height. Available evidence suggests that growth retardation might be the result of late referral and/or suboptimal clinical care in children with CRF. Management of malnutrition, renal osteodystrophy, metabolic acidosis, salt wasting and anemia should be optimal before recombinant human growth hormone initiation.

Key words: Chronic renal failure, children, growth retardation, growth hormone

It has long been recognized that chronic renal failure (CRF) in children is associated with growth delay[1]. Still In our daysNevertheless, growth retardation remains today a major impediment to the full rehabilitation of children with CRF (Fig. 1)[2]. The reduction of in height velocity frequently results in diminished final adult height[3]. Psychosocial consequences of short stature, such as difficulties in peer relationships and self-esteem, have been well documented[4,5]. The children with both CRF and short stature might be particularly vulnerable in these problems[6].

In a recent study, Ggrowth failure was associated in a recent study with a more- complicated clinical course and increased risk of death for children with kidney failure. At In the same study, a higher proportion of deaths in children with growth failure was found, and were which was attributed to infectious causes[14].

Several factors have been identified as contributors to impaired linear growth, and they includeing protein and calorie malnutrition, metabolic acidosis, salt wasting, anemia, and renal osteodystrophy (Fig. 2)[7]. In addition, there is evidence forof a correlation between solute clearance and growth, with residual renal function exerting a significant influence on that outcome[15]. Despite vigorous treatment of these factors, patients with CRF continued to demonstrate poor growth poorly. It was hoped that, with the advent of modern dialysis and transplantation, these patients would have experience normal growth or even catch-up growth. Although normal growth may be seen after transplantation, catch-up growth is rare[7].

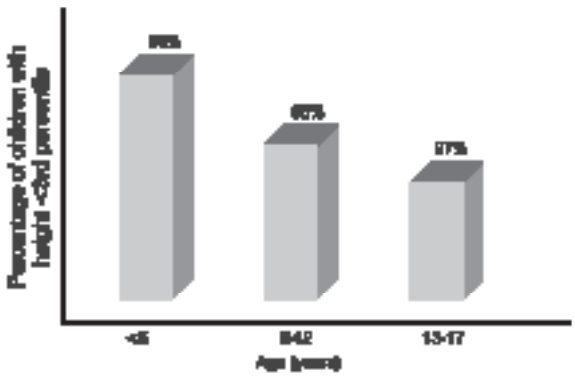

Fig 1. Percentage of children with height <3rd percentile (SDS <–1.88), North American Pediatric Renal Transplant Cooperative Study, 1996. Annual Report[2].

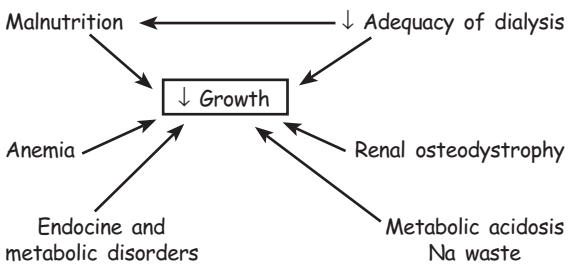

Fig. 2. Etiology of growth failure in children with chronic renal failure.

In the early 90's, a significant improvement of in the growth rate of children with recombinant human growth hormone (rhGH) has been documented in various multicenter studies in children on conservative treatment, dialysis and after renal transplantation[8,9,10,11,12]. After more than a decade of experience, the safety and efficacy of long-term treatment with recombinant human growth hormone (rhGH) in children on peritoneal dialysis has been established[13].

Assessment and interpretation of growth and nutritional status.

The reliable assessment of growth and nutritional status growth of children with CRF requires staff who have received training in the use of appropriate measuring techniques and equipment. Weight, height (or supine length for patients up to 2-3 years orf age) and head circumference (for children up to 2 years of age) should be measured and plotted so that growth velocity can be calculated. The growth in height is divided by mathematical modelling in three phases: infancy, childhood and puberty. There are differences in growth regulation during these phases.

a) During the first two years of life, nutrition is the most important factor for growth. ApPproximately 30% (40 cm) of the total postnatal statural growth occurs in this period[18].
b) During childhood, the role of the somatotropic hormone axis becomes more important and thyroid hormone and nutrition have a role of lesser importance. Height velocity is decelerating in this period, (Fig. 3) to an almost constant rate approximately of approximately 5 cm/year (Fig. 3).
c) In puberty, the gonadotropic hormone axis plays a major role. On average, the growth rate doubles during puberty. The growth spurt is lastsing between 2.5 and 3 years, and is startsing in girls at approximately 11 years of age and in boys about two years later. The average gain in height during the growth spurt is 25 cm in girls and 28 cm in boys. This pattern of pubertal growth was recently confirmed in a control group of end-stage renal disease (ESRD) patients followed in the late 1990s who were not treated with recombinant rhGH[19].

The extent of growth retardation depends on the period that in which CRF was manifested. Onset of CRF in utero or during infancy is

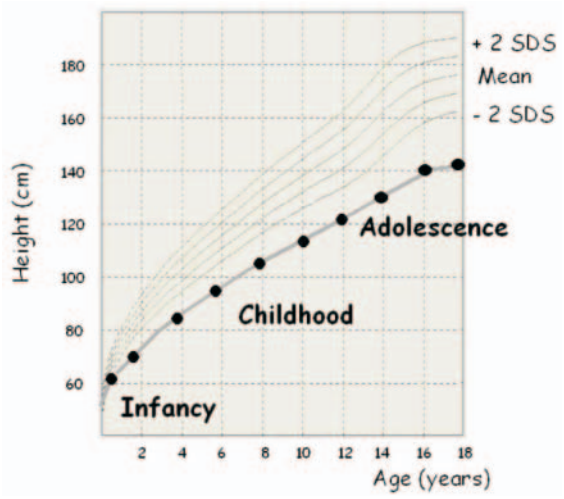

Fig. 3. Height curve of a boy with chronic renal failure (CRF) from infancy.

associated with significantly diminished final height. Growth of children with manifestation of CRF during the first two years of life was affected in 50% of them. It was also found that height standard deviation score (SDS) was already reduced at birth, and decreased further during the first 3three postnatal months. Then, after a transient stabilization of growth rates, a further loss in relative height apparently occurs between the 9th and 18th months of age[18]. During childhood, these patients usually have a growth pattern parallel to the percentile curves (Figure. 1). However, a significant decrease of in growth velocity might occur in these patients when there is not appropriate management of the contributing factors of to the development of growth failure are not appropriately managed. Finally, pubertal height gain of CRF patients is only 50% of that observed in healthy children. In addition, on average, the onset of puberty in these children is delayed by 2 years.

Clinical assessment of children should be combined with regular dietary assessments, which can be withconsist of three-day dietary diaries or by dietary recall in the clinic by an experienced dietician. Nutrient intakes should be computer analyszed and reference made to national guidelines.

Methods for assessment of body composition are usually based on a two- or three- component model and use several different measurement techniques. Two component models divide the body into fat mass or fat-free mass

(the remainder after fat is subtracted). The three-component model divides the body into fat mass and two components of fat-free mass (bone mineral and lean tissue). A two-component criterion model typically uses hydrodensitometry (hydrostatic weighing) measurement technique as a gold standard, and in clinical practice anthropometric measurements and bioelectric impedance (BIA) are used. The three-component model uses dual-energy x-ray absorptiometry (DEXA) measurements. With carefully applied skinfold[16] or BIA methods, it is possible to estimate relative body fat percentage with an error of 3% to 4%. However, when poor measurement techniques are applied or if the measurement equipment is poorly maintained and calibrated, the errors associated with the body composition estimate will be much larger.

Serum albumin has been identified as a reliable marker for nutritional status. In addition, it has become increasingly clear that there is an inverse relationship between serum albumin and mortality rates in adults maintained on chronic dialysis. While dietary protein intake and dialysis adequacy are important variables determining nutritional status, there is increasing evidence linking chronic inflammation in uremia and nutritional status. Such a finding could be consistent with chronic inflammation playing a role in determining the albumin concentration in addition to nutritional status.

Nutrition and Growth

Children with CRF on conservative treatment or on dialysis are often anorectic. In the past, malnutrition was considered as the main cause of growth retardation in these patients. The negative effect of malnutrition on growth during the first two years of life is well established[19]. However, no correlation was found between energy intake and growth rate in older children[20]. A minimum of energy intake of more than 70% of the recommended daily allowance (RDA) is generally accepted as a prerequisite for normal growth velocity. Attempts to improve growth in older children with high-energy diets were generally disappointing[21]. In a recent multicenter study, was found that energy intake was found to be less than 70% in 20% of the children. It was of interest that only 4% of patients lost weight in relation to height during a mean follow-up of 2.1 years. Therefore, it is reasonable to assume that the majority of these patients had adequate energy intake and poor growth[22]. In all children with growth failure before rhGH treatment, aggressive nutritional intervention should be started when their weight -for -height standard deviation scoreSDS is not acceptable (< -2) in the absence of oedema.

An increase in resting energy expenditure has been described in children treated with rhGH, possibly related to increased protein turnover[23]. Therefore, meticulous nutritional care should also be provided at in the period of rhGH treatment in order to achieve an energy intake of 100% of recommended daily allowances (RDA) and to administer the appropriate amount of protein. There is evidence that there is a positive effect of rhGH treatment on protein metabolism. An improvement in nitrogen balance as evidenced by a falling of blood urea nitrogen and urea nitrogen appearance with a constant protein intake was noticed in nine prepubertal patients on peritoneal dialysis treated with rhGH. A significant increase in serum creatinine and creatinine excretion with a constant weekly creatinine clearance and an the increase in mid-arm muscle circumference were indications of an improvement in lean body mass. In addition, there was an improvement in the pattern of plasma amino acids and an increase in serum albumin, possibly as a result of the improvement of in protein metabolism[24]. In another study, weight gain and an increase of insulin-like growth factor-1 (IGF-1) and transferrin levels was were found in malnourished dialysis patients treated with rhGH. A decrease of BUN level was also documented, despite the constant oral intake, suggesting that short-term rhGH administration was associated with an anabolic reaction in these patients[25]. In addition, a significant increase of in lean body mass was found in thirty-three 33 prepubertal patients with CRF treated for two years with rhGH[26].

In summary, available evidence suggests that growth retardation might be the result of late referral and/or suboptimal clinical care[27]. Management of malnutrition, renal osteodystrophy, metabolic acidosis, salt wasting and anemia should be optimal before rhGH initiation. Finally, there is some recent evidence that the beneficial effect of rhGH on height might result in an eventual increase in adult height[18,28].

REFERENCES

1. West CD, Smith WC. An attempt to elucidate the cause of growth retardation in renal disease. Am J Dis Child 1956; 91: 460-465.
2. Fivush BA, Jabs K, Neu AM , Sullivan EK3, Feld L, Kohaut E, Fine Ret al. Chronic renal insufficiency in children and adolescents: the 1996 annual report of NAPRTCS. Pediatr Nephrol (1998); 12: 328-337.
3. Rizzoni G, Broyer M, Brrunner FP, et al. Combined report on regular dialysis and transplantation of children in Europe. European Dialysis and Transplantation Association Registration Committee., 1986.
4. Law CM. The disability of short stature. Arch Dis Child 1987; 62: 855-859.
5. Gordon M, GCrouthamel C, Post EM, Richman N. Psychosocial aspects of constitutional short stature;: social competence, behaviour problems, self-esteem and family functioning. J Pediatr 1982; 101: 477-480.
6. Reynolds JM, Wood AJ, Eminson DM, Postletwaite RJ. Short stature and chronic renal failure: what concerns children and parents? Arch Dis Child 1995; 73: 36-42.
7. Kohaut EC. Chronic renal disease and growth in childhood. Curr Opin Pediatr 1995; 7(2): 171-175.
8. Van Es A. Growth hormone treatment in short children with chronic renal failure and after renal transplantation: combined data from European clinical trials. The European Study Group. Acta Paediatr Scand Suppl 1991; 379 : 42-48.
9. Tonshoff B, Tonshoff C, Mehls O, Pinkowski J, Blum W, F, Heinrich U, Stover B, Gretz Net al. Growth hormone treatment in children with preterminal chronic renal failure: no adverse effect on glomerular filtration rate. Eur J Pediatr 1992; 151: 601-607.
10. Mehls O, Broyer M. Growth response to recombinant human growth hormone in short prepubertal children with chronic renal failure with or without dialysis. The European/Australian Study Group. Acta-Paediatr-Suppl 1994; 399: 81-87.
11. Fine RN., Kohaut EC, Brown D, Perlman A J. Growth after recombinant human growth hormone treatment in children with chronic renal failure: report of a multicenter randomized double-blind placebo-controlled study. Genentech Cooperative Study Group. J Pediatr 1994; 124: 374-382.
12. Benfield MR, Parker KL, Waldo FB, Overstreet SL, Kohaut EC. Growth hormone in the treatment of growth failure in children after renal transplantation. Kidney Int - Suppl 1993; 43: S62-64.
13. Schaefer F, Haffner D, Wuhl E, Mehls O. Long-term experience with growth hormone treatment in children with chronic renal failure. Perit Dial Int 1999; 19 19 (Suppl) 2: S467-472.
14. Furth SL, Hwang W, Yang C, Neu AM, Fivush BA, Powe NR. Growth failure, risk of hospitalization and death for children with end-stage renal disease. Pediatr Nephrol 2002; 17(6): 450-455.
15. Chadha V, Blowey DL, Warady BA. Is growth a valid outcome measure of dialysis clearance in children undergoing peritoneal dialysis? Perit Dial Int 2001; 21 (Suppl) 3: S179-184.
16. Harrison, G. G., Buskirk, E. R., Lindsay Carter, J. E., Johnston, F. E., Lohman, T. G., Pollock, M. L., Roche, A. F., & Wilmore, J. H. (1988).et al. Skinfold thicknesses and measurement technique. In: T. G. Lohman TG, A. F. Roche AF, & R. Martorell R (Eeds.). Anthropometric Standardization Reference Manual. Champaign, IL: Human Kinetics Books; 1998.,
17. Karlberg J, Schaefer F, Hennicke M, et al. Early age-dependent growth impairment in chronic renal failure. European Study Group for Nutritional Treatment of Chronic Renal Failure in Childhood. Pediatr Nephrol, 1996; 10: 283-287.
18. Haffner D, Schaefer F, Nissel R, et al. Effect of growth hormone treatment on adult height of children with chronic renal failure. N Engl J Med, 2000; 343: 923-930.
19. Rees L, Rigden SPA, Ward GM. Chronic renal failure and growth. Arch Dis Child 1989; 64: 573-577.
20. Betts PR, Magrath G, White RHR. Role of dietary energy supplementation in growth of children with chronic renal insufficiency. Br Med J; 1977; I: 416-420.
21. Arnold WC, Danford D, Holliday MA (1983). Effects of caloric supplementation on growth in children with uremia. Kidney Int 1983; 24: 205-209.
22. Wingen AM, Fabian-Bach C, and Mehls O. (1993) Evaluation of protein intake by dietary diaries and urea-N excretion in children with chronic renal failure. Clin Nephrol 1993; 4: 208-215.
23. Gregory JW, Greene SA, Jung RT, Scrimgeour CM, Renme MJ. (1991) Changes in body composition and energy expenditure after six weeks' growth hormone treatment. Arch Dis Child 1991; 66: 598-602.
24. Stefanidis CJ. Is rhGH anabolic in patients undergoing peritoneal dialysis? Br J Clin Pract Suppl. 1996; 85: 44-46.
25. Iglesias P, Diez JJ, Fernandez-Reyes MJ, Aguilera A, Burgues S, Martinez-Ara J, Miguel JL, Gomez-Pan A, Selgas Ret al. Recombinant human growth hormone therapy in malnourished dialysis patients: a randomized controlled study. Am J Kidney Dis 1998; 32(3): 454-463.
26. van der Sluis IM, Boot AM, Nauta J, Hop WC, de Jong MC, Lilien MR, Groothoff JW, van Wijk AE, Pols HA, Hokken-Koelega AC, de Muinck Keizer-Schrama SMet al. Bone density and body composition in chronic renal failure: effects of growth hormone treatment. Pediatr Nephrol 2000; 15(3-4): 221-228.
27. Furth SL, Alexander DC, Neu AM, Hwang W, Powe NR, Fivush BA. Does growth retardation indicate suboptimal clinical care in children with chronic renal disease and those undergoing dialysis? Semin Nephrol 2001; 21(5): 463-469.
28. Fine RN, Sullivan EK, Tejani A. The impact of recombinant human growth hormone treatment on final adult height. Pediatr Nephrol 2000; 14(7): 679-681.