

Load Tests of the Renal form of Primary Hyperparathyroidism in Children

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Abstract

After the introduction of calcium chloride (12.4 mg/kg) examined the levels in the blood at 20 and 120 minutes. The calcium content in a comparison group of children after 120 minutes returned to the baseline, in patients with a renal form of primary hyperparathyroidism its level was greater than 1.3 times. The test was sensitive and provided an opportunity to reveal hypercalcemia in 39 children who had been the normo- and hypocalcemia. The impaired renal function had no effect on the significance of the test. Osmotic hypertension develops under the influence of hypertonic sodium chloride. In osmotic diuresis, the excretions of calcium and sodium cations are interdependent. Increasing sodium in the loops of Henle and distal renal tubules stimulates sodium excretion, decreased reabsorption, which leads to increased levels of calcium in the daily urine in children with primary hyperparathyroidism. Test with sodium chloride made it possible to detect hypercalciuria in 12 (21.43%) children who have had normal levels of calcium in urine.

Keywords: Load test, hyperparathyroidism, renal, children, hypercalciuria.

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Introduction

Solving the problem of diagnosing the renal form of primary hyperparathyroidism (RF HPT) in children, it prevents the development of its complications.^[1] The latent course of the process, the polymorphism of forms, the absence of specific laboratory tests is the reason for the delayed and erroneous diagnosis of primary hyperparathyroidism, leading to the early formation of severe forms of urolithiasis.^[2,3,4] It is known that the study of the content of calcium and phosphorus in the blood and in the daily urine is not enough to diagnose primary hyperparathyroidism, normal levels of calcium and phosphorus in the blood serum do not exclude primary hyperparathyroidism.^[5,6,7]

The purpose of the study: To determine the value of load tests in the diagnosis of the renal form of primary hyperparathyroidism in children.^[8,9,10]

Subjects and Methods

From 2008 to 2022, 852 children with urolithiasis were admitted to our clinic. Based on clinical, biochemical and instrumental studies (the content of total calcium and inorganic phosphorus in blood and in daily urine, ionized calcium, stress tests with calcium and sodium chloride, the content of parathyroid hormone (PTH), calcitonin (CT), vitamin D and cyclic 3,5-adenosine monophosphate (cAMP) in blood serum. Of the instrumental methods: X-ray densitometry of the hand bones and ultrasound osteometry),

56 (6.79%) children were diagnosed with a renal form of primary hyperparathyroidism. The article analyzes the results of the study of load samples with calcium and sodium chloride.

The calcium loading test was performed by intravenous administration of 10% calcium chloride solution at the rate of 12.4 mg/kg. The serum calcium content was examined before and after the test for 20 and 120 minutes.

The transport of calcium cation in the renal tubules is associated with sodium cation. Sodium is an osmotically active substance. Osmotic hypertension develops under the influence of hypertonic sodium chloride solution. In the conditions of osmotic diuresis, the excretion of sodium and calcium are interrelated. What is the basis of the load test with 5% sodium chloride (0.125 ml /kg/min for 45 minutes).

Results & Discussion

Of 56 children with renal form of primary hyperparathyroidism, hypocalcemia was observed in 14 (25.0%) children, hypophosphatemia in 13 (23.2%) children. Normocalcemia was observed in 34 (60.7%) children and in 5 (8.9%) children the calcium content was below normal. 35 (60.7%) children had normophosphatemia and only 5 (8.9%) children had hyperphosphatemia. Hypercalciuria was observed in 44 (78.8%) children and hyperphosphaturia in 40 (71.4%) children, in the remaining children the indicators were within normal values. The total calcium content in the

blood of children of the control group (patients with urolithiasis) was equal to 2.31 ± 0.12 mmol / liter, at 20 minutes after the introduction of calcium chloride, it increased to 2.93 ± 0.12 mmol / liter ($p < 0.02$), at 120 minutes from the moment of administration, the total calcium content returned to the initial level (2.36 ± 0.13 mmol/liter) [Table 1].

In children with the renal form of primary hyperparathyroidism, the level of total calcium before the test was equal to 2.36 ± 0.14 mmol/liter, at 20 minutes it increased to 2.97 ± 0.13 mmol/liter ($p < 0.05$). At 120

minutes, the total calcium content was 3.03 ± 0.1 mmol/liter ($p < 0.02$).

The study of the effect of sodium on calcium homeostasis was carried out by intravenous administration of 5% sodium chloride solution (0.125 ml/kg/min for 45 minutes) which increases the excretion of calcium through the tubular apparatus of the kidneys. The study of the calcium content in the blood and in the daily urine was carried out before and after the sample [Table 2].

Table 1: Results of the calcium sample in the examined children (mmol/liter)

| Analysis | Total calcium content (before the trial) | Total calcium content at 20 minutes | Total calcium content at 120 minutes |
|--|--|-------------------------------------|--------------------------------------|
| Children with urolithiasis (n=60) | 2,31±0,12 | 2,93±0,12* | 2,36±0,13 |
| Children with renal form of primary hyperparathyroidism (n=56) | 2,36±0,14 | 2,97±0,13* | 3,03±0,1* |

Note: * - confidence in relation to the indicator before the sample

Table 2: Results of a test with a load of 5% sodium chloride in children

| Analyzed groups | Indicators of calcium content | | | |
|--|-------------------------------|---------------------------|-------------------|---------------------------|
| | Before the trial | | After the trial | |
| | in blood (mmol/l) | per day. urine (mmol/day) | in blood (mmol/l) | per day. urine (mmol/day) |
| Children with urolithiasis (n=60) | 2,41±0,17 | 2,22±0,21 | 2,38±0,135 | 2,43±0,2 |
| Children with renal form of primary hyperparathyroidism (n=56) | 2,45±0,17 | 3,85±0,22 | 2,45±0,14 | 6,07±0,25* |

Note: * reliability of indicators before and after the sample

The calcium content in the daily urine in children of the control group (patients with urolithiasis) before the test was 2.22 ± 0.21 mmol / day, after the test this indicator increased to 2.43 ± 0.20 mmol/ day ($p > 0.05$).

In children with the renal form of primary hyperparathyroidism, the level of calcium in the daily urine before the test (3.85 ± 0.22 mmol / day) it was higher in comparison with the indicator of children of the control group (2.22 ± 0.21 mmol / day) ($p < 0.01$), the introduction of 5% sodium chloride solution (0.125 ml / kg for 45 minutes) it contributed to a further increase in its level in urine (6.07 ± 0.25 mmol /day) ($p < 0.001$).

The content of total calcium in the blood serum of children of the comparison group (children with urolithiasis) before and after the test practically remained at the same level (2.41 ± 0.17 and 2.38 ± 0.13 mmol/liter, respectively), a slight increase in this indicator was observed in the daily urine after the test (2.22 ± 0.21 and 2.43 ± 0.2 mmol/day, respectively).

In children of patients with the renal form of primary hyperparathyroidism, the level of serum calcium in the blood before and after the test, as well as in the comparison group, remained at the same level (2.45 ± 0.17), but in the daily urine there was a significant increase in this indicator after the test by 1.6 times ($p < 0.001$). When comparing the calcium content in the daily urine after the test, this contingent of sick children with the comparison group showed a significant

increase of 2.5 times ($p < 0.001$), its blood level increased slightly ($p > 0.05$).

Discussion: Artificial increase in the level of calcium in the blood, reduces the function of the parathyroid gland, stops the absorption of calcium through the intestinal walls, reduces the reabsorption of calcium. Calcitonin produced by the thyroid gland contributed to the normalization of serum calcium levels in children of the control group.

In primary hyperparathyroidism, adenomatous and (or) hyperpalasized parathyroid glands, working autonomously, produce excess parathyroid hormone, the latter increases the absorption of calcium through the intestinal wall, promotes the release of calcium from bone tissue into the blood, increases the reabsorption of calcium in the distal renal tubules.

Thus, in the body of children with a renal form of primary hyperparathyroidism after the introduction of calcium, its level remains within high figures. The test was sensitive and made it possible to detect hypercalcemia in the examined children who had normocalcemia (34 children) and hypocalcemia (5 children). Impaired renal function did not affect the significance of the sample.

The transport of calcium cation in the renal tubules is associated with sodium cation. The content of these cations in the renal tubules varies proportionally. Under the influence of hypertonic sodium chloride solution, osmotic

hypertension develops. In the conditions of osmotic diuresis, the excretion of calcium and sodium cations is interrelated. Obviously, an increase in the level of sodium in the Henley loops and distal renal tubules stimulates the excretion of sodium, reducing its reabsorption, which leads to an increase in the level of calcium in the daily urine in children with primary hyperparathyroidism.

Conclusion

The sodium chloride test turned out to be a sensitive method, and made it possible to detect hypercalciuria in 12 (21.43%) children who had normocalciuria.

Thus, stress tests with calcium and sodium chloride are specific diagnostic tests and increase the effectiveness of the diagnosis of the renal form of primary hyperparathyroidism, help to differentiate primary hyperparathyroidism from other hypercalcemic and hypercalciuric conditions.

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