# CALCIUM METABOLISM IN A CASE OF INFANTILE TETANY.*

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Quite recently MacCallum and others[1] have studied calcium metabolism in dogs suffering from post-operative tetany in consequence of parathyroidectomy. The administration either of soluble calcium salts or of parathyroid tissue relieves the tetany in such dogs. This work led us to study a case of infantile tetany which was available. The clinical aspects of the case have been reported elsewhere.[2]

The child was a negro girl, fourteen months of age when first seen (December, 1908), at which time the tetany was well marked. No benefit was derived from change of diet or from the administration either of calcium lactate (six grains per day) or of desiccated ox parathyroid (twenty-two grains per day). The child lost weight.

The treatment just described was discontinued on January 4, 1909, and a constant diet (500 cubic centimeters of milk diluted with 500 cubic centimeters of distilled water per day) was begun, which was kept up for two months. During this period the body weight (fourteen pounds) varied but slightly. During the metabolism periods the child was confined to a specially constructed bed, consisting of a Bradford frame. On this frame, in the middle where there was no canvas, a rubber ring pneumatic pad was placed. The buttocks lay in the open space of the pad. The pad rested on a collecting can, in which a wire screen caught the

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[1] MacCallum and Voegtlin, *Jour. Exper. Med.*, 1909, xi, 118; Berkeley and Beebe, *Jour. Med. Research*, 1909, xx, 149; Cooke, *Jour. Exper. Med.*, 1910, xii, 45.

[2] H. J. Gerstenberger, *Cleveland Med. Jour.*, 1909, vii, 671.

feces, the urine being drained off into a bottle. The arms and legs were secured to the bed. On account of constipation, it was possible generally to obtain feces and urine separate from one another. On some days, however, accidental mixing of these prevented estimation of calcium excretion.

The metabolism work began on January 11, one week after the beginning of the constant diet. Rest periods of one to two weeks had to be allowed, to prevent injury to the child from the confinement. The details of our experiments are given in table I, p. 316.

The symptoms of tetany remained well marked during the entire time of the first metabolism experiment (January 11 to February 17), there being no improvement as a result of the administration of calcium lactate (two grains four times a day) or of the subcutaneous injection of emulsion of fresh parathyroid. When the milk diet was discontinued on March 5, the patient improved; and from the latter part of March until about October 1 tetany was entirely absent. We had planned to study the normal calcium metabolism during October, but were prevented by return of the symptoms.

Early in November, while in the stage of partial recovery, the second metabolism experiment was carried out. This furnished complete data for seven days, the urinary calcium being estimated for each day, but the calcium of the milk and of the feces being estimated in aliquot parts of the entire amount for the week. The diet consisted of 1,000 cubic centimeters of milk daily. The symptoms of tetany were in abeyance. This period was, therefore, a latent stage of the disease, and metabolism was presumably more nearly normal than during the first metabolism period. The child was two years old at this time.

The methods of analysis were the same as those used by Renvall,[3] except that the calcium oxalate obtained from the urine was so small in amount that it was estimated by titration with permanganate.

In this table the calcium ingested and excreted is expressed as grams of calcium oxide.

The estimation of calcium of the mixed milk for February 9 to 12 seemed too high, but a second analysis gave the same figure.

[3] Renvall, *Skandinav. Arch. f. Physiol*, 1904, xvi, 97.

TABLE I.

| Date | Calcium ingested. | | | Calcium excreted. | | | Remarks. |
|---|---|---|---|---|---|---|---|
| | In food. | In calcium lactate. | Total. | In urine. | In feces. | Total. | |
| Jan. 11 | 0.6135 | 0.0 | 0.6135 | 0.0175 | 0.4325 | 0.4500 | Age, about 15 months |
| Jan. 13 | 0.6300 | 0.0 | 0.6300 | 0.0294 | 0.6110 | 0.6404 | Jan. 12, excreta lost |
| Jan. 14 | 0.7400 | 0.0943 | 0.8343 | 0.0400 | 0.5630 | 0.6030 | Jan. 14–17, calcium lactate given |
| Jan. 15 | 0.6425 | 0.0943 | 0.7368 | 0.0360 | 0.4555 | 0.4915 | |
| Jan. 17 | 0.7400 | 0.0943 | 0.8343 | 0.0498 | 1.0140 | 1.0638 | Jan. 16, excreta lost |
| ..... | | | | | | | Jan. 17–30, rest period |
| Jan. 31 | 0.6000 | 0.0943 | 0.6943 | 0.0255 | 0.5640 | 0.5895 | Jan. 27–Feb. 2, calcium lactate |
| Feb. 2 | 0.7500 | 0.0943 | 0.8443 | 0.0220 | 0.7150 | 0.7370 | Feb. 1, excreta lost |
| ..... | | | | | | | Feb. 2–8, rest period |
| Feb. 9 | 0.9300 | 0.0 | 0.9300 | 0.0165 | 0.2080 | 0.2245 | |
| Feb. 10 | 0.9300 | 0.0 | 0.9300 | 0.0365 | 1.0740 | 1.1105 | Feb. 11, excreta lost |
| Feb. 12 | 0.9300 | 0.0 | 0.9300 | 0.0180 | 0.8100 | 0.8280 | |
| ..... | | | | | | | Feb. 12–15, rest period |
| Feb. 16 | 0.8000 | 0.0 | 0.8000 | 0.0178 | [0.7653] | | Ox parathyroid subcutaneously |
| Feb. 17 | 0.8000 | 0.0 | 0.8000 | 0.0233 | | | Weight, 14 lbs. Tetany present |
| Nov. 5 | | | | 0.0185 | | | Age, 2 years |
| Nov. 6 | | | | 0.0379 | | | Latent stage of tetany. |
| Nov. 7 | | | | 0.0491 | | | |
| Nov. 8 | | | | 0.0654 | | | |
| Nov. 9 | | | | 0.0960 | | | |
| Nov. 10 | | | | 0.0584 | | | |
| Nov. 11 | | | | 0.0554 | | | |
| Total Nov. 5–11 | 10.8100 | 0.0 | 10.8100 | 0.3807 | 9.0400 | 9.4207 | |

The calcium figure for the combined feces, February 16 to 17, can not be considered to represent the full excretion for two days.

*Discussion of Results.*—First, as regards the excretion of calcium by the urine, the average daily urinary calcium oxide for January 11 to 13 and February 9 to 17 was 0.0227 gram; but for January 14 to February 2, when calcium lactate was given, the daily average was 0.0348 gram. There was, therefore, slight increase of urinary calcium when calcium lactate was ingested.

In the second experimental period in which the conditions were different, namely, the quantity of milk taken, the age and condition of the patient, the urinary excretion was higher, averaging 0.0544 gram per day. For the seven non-calcium days of the first experiment, the percentage of the calcium ingested that appeared as urinary calcium was 2.8, and for the five calcium lactate days it was 4.4; while during the second experiment, the percentage that appeared in the urine was 3.5.

A more important point is the question of retention of calcium. In the case of adults it has been found[4] that there is an approximate balancing of the calcium ingested and excreted, provided the quantity taken in is neither too low nor too high (*i. e.,* between 0.4 and 1.1 gram of calcium oxide per day, the amount differing with different individuals).

In the case of children, there is normally more calcium taken in than is excreted, *i. e.,* there is retention of calcium. On cow's milk the percentage retained is much lower than on breast milk. Blauberg,[5] in the case of a healthy child seven and one-half months old (7,570 grams body weight) on a diet of undiluted cow's milk containing two grams calcium oxide per day, found 44.4 per cent. retention. Cronheim and Müller,[6] with a healthy six months old child (7,800 grams body weight) on raw cow's milk containing 1.5 gram of calcium oxide daily, found 10.6 to 15 per cent. retention. The lower calcium intake in the latter case may explain the lower figure for retention. Cybulski[7] observed 20.8 per cent. retention in a case of tetany in a child seven months old when taking cow's milk. When compared with Blauberg's figures for a child of the same age, this would indicate diminished retention of calcium during tetany. Iddo[8] also reported diminished retention in tetany. In Cybulski's case there was marked increase of retention on breast milk, the percentage of retention increasing as the child recovered, reaching as high as 87.2. In our case the retention during five non-calcium days (January 11 to 13 and February 9 to 12) was 19.4 per cent., and during the calcium lactate days, 11.7 per cent.; while during the seven days of the final experiment it was 12.8 per cent. Calcium administration did not seem to favor calcium retention in the least. Several investigators[9] have found that in the the case of

[4] Bertram, *Ztschr. f. Biol.,* 1878, xiv, 354. See also von Wendt, *Skandinav. Arch. f. Physiol.,* 1905, xvii, 211; Sherman, Mettler and Sinclair, Calcium, Magnesium, and Phosphorus in Food and Nutrition, *U. S. Dept. of Agric., Bull. No. 227,* 1910.

[5] Blauberg, *Ztschr. f. Biol.,* 1900, xl, 19.

[6] Cronheim and Müller, *Biochem. Ztschr.,* 1908, ix, 79.

[7] Cybulski, *Monatschr. f. Kinderheilk.,* 1906, v, 409.

[8] Quoted by Netter, *Compt. rend. Soc. de biol,* 1907, lxii, 376.

[9] Bertram, *loc. cit.;* Renvall, *loc. cit.;* von Wendt, *loc. cit.;* Herxheimer, *Berl. klin. Wchnschr.,* 1897, xxxiv, 423.

healthy adults retention of calcium occurred when calcium salts were given.

Stoeltzner[10] argued that infantile tetany was due to poisoning of the organism by calcium. This theory would call for increased retention of calcium, which has not been observed. Cerebral excitability has not been found to be associated with increased calcium content of the brain. In the cortex of the brain of children that died of tetany, Quest[11] found less calcium than in the brains of other children of the same age.

Artificial tetany in dogs is, possibly, quite a different disease from human tetany. Calcium salts and parathyroid injection, which are so efficient in removing the symptoms in animals, produced no effect in our case. Furthermore, Cooke[12] found the calcium excretion of normal and of parathyroidectomized dogs to be quite similar, and reports that the calcium content of the brain of tetany dogs is not lower than that of normal dogs.

[10] Stoeltzner, *Jahresb. f. Kinderheilk*, 1906, lxiii, 661.
[11] Quest, *Jahresb. f. Kinderheilk.*, 1905, lxi, 114.
[12] Cooke, *loc. cit.*