

琉球大学学術リポジトリ

休産鶏および産卵鶏の血中カルシウム濃度に及ぼす パラサイロイド除去の影響(畜産学科)

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The Influence of Parathyroidectomy on the Plasma Calcium Concentration in Nonlaying and laying hens

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Summary

This study examines the effect of a parathyroidectomy on the calcium concentration in the blood of nonlaying hens. To eliminate the influence of the ovary and to clarify the effect of parathyroidectomy, hypophysis was also removed. The results obtained are as follows:

1) In nonlaying and in the hypophysectomized hens, the plasma calcium concentration did not vary because of the parathyroidectomy and showed a constant concentration of 10mg%.

2) In laying hens, the parathyroidectomy caused a rapid decrease of the blood calcium concentration from 24mg% to about 10mg% within one day, but it returned to a normal concentration of about 20mg% after 4 days.

From these results it appears that the parathyroid gland as well as the ovary may not play an important role in maintaining the blood calcium in nonlaying hens, whereas these two organs independently affect the blood calcium of laying hens. What causes the recovery to a normal concentration of blood calcium from a marked drop in the concentration in the parathyroidectomized laying hens remains unknown.

Introduction

In laying hens, the calcium concentration in the blood plasma fluctuates from 20 to 30mg% during their egg production³⁾. It is well known that the ovary⁵⁾ and the parathyroid gland⁹⁾ play an important role in maintaining a physiological concentration of circulating calcium. On the other hand, in nonlaying hens the plasma calcium concentration does not vary more than 10mg%¹²⁾. But it is not known what regulates the constant concentration of the plasma calcium.

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In this experiment, the role of parathyroid gland on the maintenance of the plasma calcium in nonlaying hens was examined by the removal of this gland.

Materials and Methods

Birds

White Leghorn hens (13 months of age) which had not been laying more than 3 weeks and had been undergoing annual molting were used as nonlaying hens. Those which had been laying more than 3 eggs in a clutch with a one day pause between clutches were used as laying hens. They were kept in individual cages on a commercial ration containing about 3% calcium and water given *ad libitum* and were exposed to 14 hours of light from 0500 to 1900 each day.

Operating Procedures

To eliminate the influence of the ovary on the concentration of the plasma calcium in nonlaying hens, hypophysectomies were made using the method of Tanaka and Nobukuni¹¹⁾, with a slight modification⁷⁾. Parathyroidectomies in the hypophysectomized hens were conducted on hens from which the hypophysis had been removed more than 10 days previous. Parathyroidectomies were performed by procedures similar to those of Benoit et al²⁾. and Polin and Sturkie¹⁰⁾. As control group of hens, submitted to a mock operation, were treated in exactly the same manner as those just described, except that no portion of hypophysis and parathyroid gland was removed. Only those hens that were verified as having a complete removal of the organs by autopsy were used for the results of this experiment.

Determining the Total Plasma Calcium

Blood samples were collected just before the operation, a half day following the operation, and at one day interval for the five days of the experimental period following the removal of hypophysis in nonlaying hens and parathyroid gland in nonlaying and laying hens. Approximately 0.5ml. of blood was taken from the wing vein with a heparinized syringe, and the plasma was obtained by centrifugation (3,000 r.p.m. for 10 min.). The calcium concentration was determined, in 0.05ml. aliquot of plasma, by using a calcium estimation kit (C-Test wako, Wako Pure Chemical Industries, LTD)⁷⁾.

Results

The changes of the blood calcium concentration before and after parathyroidectomy in the nonlaying and in the hypophysectomized hens are shown in Fig.1 and Fig.2 respectively. In the nonlaying hens, in contrast to the laying hens, the plasma calcium concentration was not influenced by these treatments.

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The blood calcium values at each point of blood collection of mock operated hens were almost the same as those of the treated hens.

The changes of the blood calcium concentration before and after parathyroidectomy in laying hens are shown in Fig.3. Although the plasma calcium concentration strikingly decreased from 24mg%, prior to the removal, to about 10 mg% on one day following parathyroidectomy, the low calcium value gradually increased and returned to a normal concentration 4 to 5 days after the operation. In the mock operated hens, the plasma calcium concentration was not significantly influenced.

Discussion

The drop in blood calcium and development of tetany in parathyroidectomized laying hens can be prevented by administering parathyroid hormone⁶⁾. In chickens fed rations that are deficient in calcium, the parathyroid gland

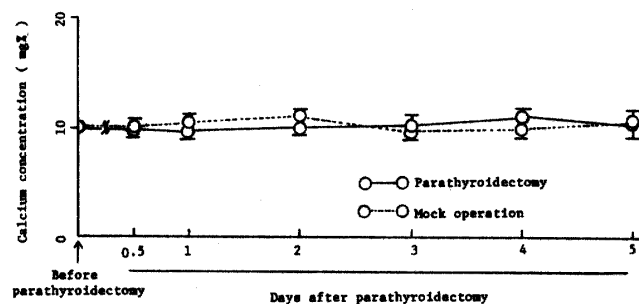


Fig. 1. Influence of parathyroidectomy on plasma calcium concentration in nonlaying hens

Each point represents the average of 10 birds. Vertical lines indicate standard deviation.

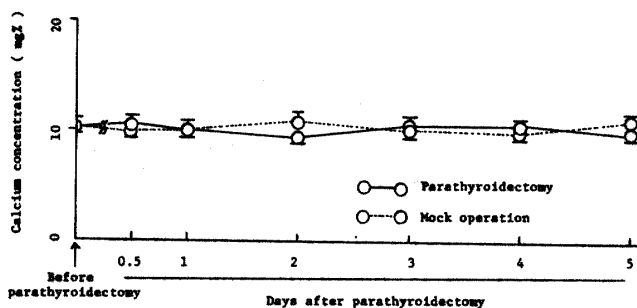


Fig. 2. Influence of parathyroidectomy on plasma calcium concentration in hypophysectomized hens

Each point represents the average of 10 birds. Vertical lines indicate standard deviation.

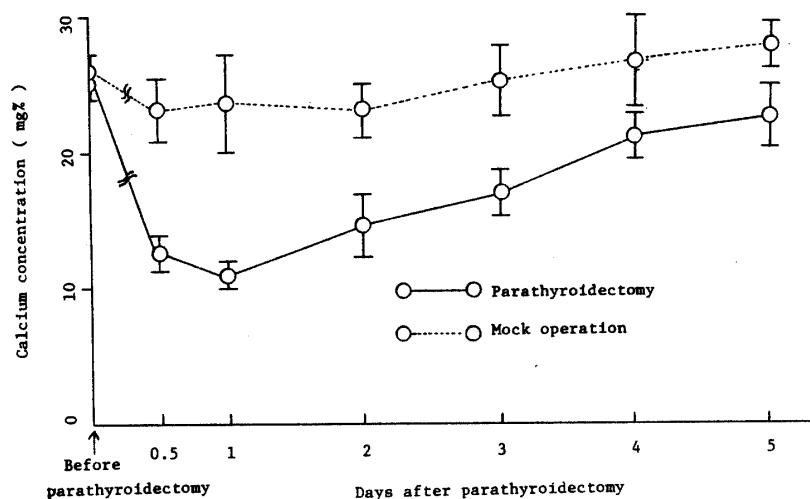


Fig. 3. Influence of parathyroidectomy on plasma calcium concentration in laying hens

Each point represents the average of 10 birds. Vertical lines indicate standard deviation.

undergoes hypertrophy and hyperplasia, more than doubling in size in many cases, though this is usually followed by a regression in size⁴⁾. It is well known that the parathyroid hormone is responsible for the regulation of blood calcium from the vast skeletal reserve in response to hypocalcemia. Conversely, hypercalcemia suppressed the production of parathyroid hormone, thus constituting a negative feed-back mechanism in the maintenance of a constant physiological concentration of plasma calcium¹⁾.

The total calcium of the plasma includes a diffusible and a nondiffusible element. In the nonlaying hen, about 60 per cent. of the blood calcium was a diffusible form (mostly in the ionic form) and is regulated by the parathyroid hormone⁸⁾. But in this experiment the removal of parathyroid gland, which is believed to be the regulator of the diffusible calcium, had no effect upon the calcium balance in nonlaying hens. The blood calcium concentration during the 5 days following the parathyroidectomy was the same as that in the intact nonlaying hens. Furthermore, the constant concentration of the blood calcium did not change in the parathyroidectomized-hypophysectomized hens.

From these results, it appears that the plasma calcium concentration of about 10mg% in nonlaying hens may be the basic level for the maintenance of their bodily functions, and the concentration of plasma calcium may be controlled by organ other than the parathyroid gland and the ovary. It is also possible that the regulation of blood calcium by the parathyroid hormone and estrogen may be made within the limit of physiological concentration higher than the basic concentration of blood calcium. In the laying hen, the ablation of the parathyroid gland caused a marked drop in calcium

within one day, even though the ovary functioned normally. Therefore, it shows that the parathyroid gland independently plays an important role in the control of blood calcium in laying hen.

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休産鶏および産卵鶏の血中カルシウム濃度 に及ぼすパラサイロイド除去の影響

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要 約

休産鶏および産卵鶏におけるパラサイロイド除去がその血中カルシウム濃度に如何なる影響を及ぼすかを調べた。また、休産鶏においては、卵巣の血中カルシウム濃度に対する影響を排除するため、まずその上位器官である下垂体前葉を除去し、10日以上経過した後パラサイロイドも除去して血中カルシウム濃度を調べた。結果は下記のとおりである。

- 1) 休産鶏および休産鶏・下垂体除去におけるパラサイロイド除去は、血中カルシウム濃度に殆んど影響を及ぼさず、その濃度は測定期間中ほぼ10mg%の安定した値を示した。
- 2) 産卵鶏におけるパラサイロイド除去は、術後1日目に血中カルシウム濃度の急激な低下を惹起した。以後日数の経過に伴ってその濃度は次第に上昇し、術後4日目から正常値へ回復した。

このような結果からパラサイロイドは卵巣と同様休産鶏の10mg%レベルの血中カルシウム濃度の維持に対して何ら役割を果していないように思われた。一方、産卵鶏においてこれら2つの器官は血中カルシウム濃度の維持に対して独立的に作用しているものと思われた。しかし、パラサイロイド除去後血中カルシウム濃度の急激な低下が日数の経過に伴って如何なる機序で正常値へ復帰するかについては不明である。

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