CALCIUM METABOLISM IN THE CHICK WITH SPECIAL REFERENCE

TO VITAMIN D₃

by

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SUMMARY

The process of calcium transport across the small intestine of the chick was studied by in vivo and in vitro techniques. Some characteristics of in vitro transport differed from the natural process. The site of calcium absorption was determined with rachitic and vitamin D₃-treated chicks. Rachitic chicks given 100 I.U. vitamin D₃ by mouth 16 hours previously showed a marked improvement in calcium absorption and similar amounts of calcium were absorbed along the whole of the small intestine in vivo. With everted gut sacs, however, the distal one-third of the small intestine transported much more calcium than the duodenal and middle sections.

On an equal weight basis, vitamin D₂ had little activity in the chick, but dihydrotachysterol series 2 and dihydrotachysterol series 3 were almost as active as vitamin D₃ for calcium transport. An immediate effect of vitamin D₃ was not seen either in vivo or in vitro. A minimum time period of 4 hours was required. It was postulated, that the delay was caused by the formation of an active calcium carrier together with its subsequent accumulation at the site of calcium transport.

The influence of certain adrenal and synthetic steroids on calcium absorption was tested in rachitic and vitamin D₃-treated chicks. Long-term administration of cortisol or 11-deoxycorticosterone interfered with the enhancement of calcium transport generally brought about by vitamin D₃. The steroids had no effect on the absorption by rachitic chicks. The inhibitory effect was not a direct antagonism of vitamin D₃ action, as cortisol, Δ¹-cortisol and 11-deoxycorticosterone enhanced
the effect of vitamin D₃ when the steroids were injected intra-
cardially 1 hour before the test.

The observations with long-term administration of cortisol
and 11-deoxycorticosterone could be correlated with interference of
adrenal function. Evidence from the use of 1-(2-chlorophenyl)-1-
(4-chlorophenyl)-2,2-dichloroethane, a specific inhibitor of the adrenal
cortex, indicated the importance of the adrenal gland in calcium
metabolism. This substance, when fed for 3 days prior to the test,
eliminated calcium transport usually brought about by vitamin D₃.

When the mechanism of calcium transport was investigated, the
evidence suggested that calcium transport under the influence of vitamin
D₃ was an active process. From studies with metabolic inhibitors, it
was deduced that the *in vitro* energy for the process was derived mainly
from glycolysis, with oxidative phosphorylation contributing to only a
small extent. Energy for calcium absorption *in vivo* did not appear
dependent upon either of these sources. A scheme was postulated to
explain active calcium transport. A carrier mechanism was suggested.

A number of tissues and tissue fluids from vitamin D₃-treated
chicks were examined for the presence of active carrier material.
However, the isolation and identification of such material was not
successful. A calcium complex was prepared from cholesterol, but
this complex could not be identified as the calcium chelate of ketone₂₅₀
nor was it found to be biologically active in the rachitic chick. The
proposed nature of the calcium carrier, believed to be derived from
vitamin D₃ by a transformation in the adrenal cortex, was discussed.