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Comparison of Renal Clearance of Calcium During Infusions of Calcium Chloride and Calcium Gluconate. (27612)

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Calcium infusions are frequently utilized in clinical and physiologic investigations of osseous and parathyroid metabolism. In general, it has not been considered necessary to control the type of calcium salt infused. In earlier work the authors suggested that renal clearance of calcium in man during a calcium infusion could be altered by the associated anion concomitantly administered(1). Subjects receiving calcium gluconate tended to have higher calcium clearances than those receiving calcium chloride. However, the design of that study did not permit a definitive conclusion to be made in this regard. The following investigation was undertaken to determine whether the two commonly used salts of calcium, calcium chloride and calcium gluconate, had comparable effects on renal clearance of calcium.

Methods. The studies were performed in the fasting state on 6 hospitalized males, ages 30 to 49 years, convalescing from acute self limited illnesses. After 3 days on a 1 g calcium, 1.5 g phosphorus diet they each received an infusion of 1 g of calcium ion as either the chloride or gluconate salt over a 4-hour period (8:30 a.m. to 12:30 p.m.). One week later each subject received an infusion of the other calcium salt. Three individuals received the calcium chloride infusion first followed by the calcium gluconate, and in the other 3 the order was reversed. Two successive 30-minute urine collections were obtained prior to the infusion. At 1½ and 3½ hours after initiating the infusion, and one hour after its completion, additional 30-minute collections were obtained. A mild water diuresis (3-5 cc/min) was continually maintained, and the subjects reclined throughout, standing only to void. Blood samples were obtained without stasis at the mid-point of each period, through an intravenous indwelling needle.

Calcium clearance was determined by dividing the quantity of calcium excreted per minute in the urine by the diffusible calcium in the serum. The latter figure was obtained by multiplying the total serum calcium by 0.65. This value represents the mean per cent diffusible calcium as previously determined in this laboratory(1). The "corrected clearance" of calcium was expressed as the ratio of the observed calcium clearance to the

simultaneously measured inulin clearance $\left(\frac{C_{Ca}}{C_{In}} \times 100\right)$, or the per cent of the filtered load of calcium excreted. This calculation standardized the clearance for variations in size of the individuals and corrected the changes in filtered load not due to changes in plasma concentration of diffusible calcium. The filtered load of calcium (mg/min) was obtained by multiplying the serum diffusible calcium (mg %) by the inulin clearance, and dividing by 100.

The chemical methods utilized in this study have been previously described(1).

Results. The results are presented in Table I and Fig. 1. The mean filtered loads of calcium prior to, during and after the 1 g calcium infusion as the chloride salt were not significantly different from those obtained when the calcium was administered as the gluconate salt.

The mean corrected calcium clearances prior to the calcium chloride and calcium gluconate infusions of 2.0 and 1.8 for the former and 2.8 and 2.9 for the latter were not significantly different. By 1½ and 3½ hours after the beginning of the infusions the mean corrected clearances for calcium during the calcium chloride infusion were 7.6 and 12.3, respectively, as compared with the higher values of 13.6 and 21.5 during the calcium gluconate infusion. These differences between the calcium chloride and calcium gluconate infusions at comparable times and equivalent filtered loads were significant ($p = <0.01$).

The difference in corrected calcium clearance persisted for at least one hour after the end of the calcium infusion but was not statistically significant.

TABLE I. Filtered Load and Corrected Calcium Clearance during Calcium Gluconate and Calcium Chloride Infusions in Six Adult Males.

Clearance period	Calcium gluconate		Calcium chloride	
	Filtered load (mg/min)	*$\frac{C_{Ca}}{C_{In}} \times 100$	Filtered load (mg/min)	$\frac{C_{Ca}}{C_{In}} \times 100$
1 hr before Ca infusion	6.8	2.8	6.7	2.0
½ hr before Ca infusion	6.6	2.9	6.5	1.8
1½ hr after start of Ca infusion	7.6	13.6	7.4	7.6
3½ hr after start of Ca infusion	9.1	21.5	8.9	12.3
1 hr after end of Ca infusion	7.7	17.1	8.4	10.5

* $\frac{\text{Calcium clearance}}{\text{Inulin clearance}} \times 100$.

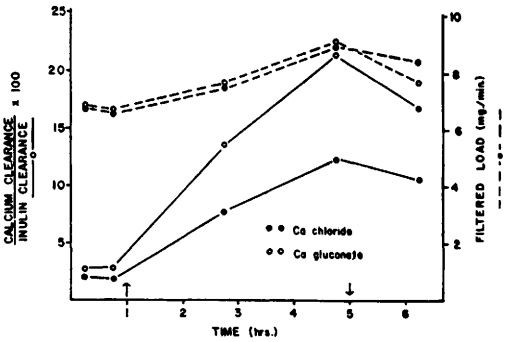

FIG. 1. Filtered load and calcium clearance during calcium gluconate and calcium chloride infusions in 6 adult males. ↑ = start and ↓ = end of infusion of 1 g of calcium ion of either salt.

Discussion. Calcium is excreted by the kidney through a combination of glomerular filtration and tubular reabsorption. Micropuncture(2) and stop-flow(3) studies have demonstrated that calcium is actively reabsorbed from the luminal fluid in the proximal convoluted tubule, the ascending loop of Henle, and the distal convoluted tubule. There is no evidence for tubular secretion of calcium. Normally 95 to 99% of the calcium is reabsorbed from the glomerular filtrate. However, when an increase in the fraction of complexed calcium in luminal fluid occurs, this reduces the amount of ionic calcium available for active tubular reabsorption, and increases the total amount excreted in the urine (3,4,5,6).

The results of this study demonstrate that at comparable filtered loads of calcium the calcium clearance during infusion of calcium gluconate is significantly higher than during

infusion of calcium chloride.

Although in the present study, direct measurements of the diffusible calcium were not obtained, the previous investigation(1) did not demonstrate a significant difference between the per cent diffusible calcium in individuals receiving infusions of calcium gluconate and calcium chloride. However, the accuracy of ultrafiltration technics are such that small, but possibly physiologically significant, changes in per cent diffusible calcium could not be detected. If the diffusible component of serum calcium were slightly greater during the calcium gluconate infusion this would contribute to the differences observed between the two salts in the present study.

Following infusions of calcium gluconate in man there is a rise in urinary organic acid, primarily gluconate(7). It has been suggested that the gluconate ion may restrict the reabsorption of calcium from the tubular fluid (3), and this is the most likely explanation for the greater clearance of calcium during the gluconate infusion.

Summary. A calcium infusion of either the chloride or gluconate salt raised the filtered load of calcium an equivalent amount. At comparable filtered loads the clearance of calcium during the infusion of calcium gluconate was higher than during the infusion of calcium chloride. The interpretation of results of tests utilizing calcium infusions should take into consideration the type of calcium salt infused.

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Prevention by Calciphylaxis of the Progeria-Like Syndrome Induced by Chronic Dihydrotachysterol Overdosage. (27613)

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Calciphylaxis enables the organism to deposit calcium selectively in certain areas. Thus, following pretreatment with parathyroid hormone or dihydrotachysterol (DHT), various calciphylactic challengers (egg white, metals, serotonin, etc.) can induce selective calcification—often with inflammation, sclerosis, necrosis or degeneration—in the skin, muscles, cardiovascular system, pancreas, salivary glands, or uterus. The phenomenon represents an induced hypersensitivity reaction to certain compounds not known to be antigenic in the usual sense(1-5).

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However, under given circumstances, calciphylaxis can also exert a considerable prophylactic effect against certain toxic compounds. Thus, the fatal generalized soft-tissue calcinosis, normally induced by acute overdosage with DHT, fails to occur if a calciphylactic challenger is brought into contact with a large connective-tissue surface. For example, if, after sensitization with DHT, albumen or iron compounds are injected into a subcutaneous air sac (granuloma pouch technic), enormous amounts of calcium precipitate in the directly challenged area and are thereby deviated from the more vital or-