CRITICAL LEVELS OF MINERAL OIL AFFECTING THE ABSORPTION OF VITAMIN A

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The practical significance of the disturbance of absorption from the intestine of vitamin A or carotenoids due to the intake of mineral oil, is still questionable. The clinical and animal experiments reported in the literature reveal controversial findings. To study this problem, therefore, the influence of different doses of mineral oil and the effect of the time of its administration on the plasma vitamin A level were investigated in order to permit an estimate as to the safe amount and optimal time for mineral oil administration. In order to have a reliable base line it was first necessary to study the influence of different levels of vitamin A ingestion on the plasma vitamin A level during an observation period of several weeks.

It has been stated that mineral oil interferes with food utilization by coating food particles in general and preventing their intestinal absorption with resulting undue loss in the feces.[1, 2] However, others found no caloric loss of food in animals on a fatty diet with 3 per cent mineral oil.[3] A series of investigators presented evidence that mineral oil ingestion is potentially harmful because the oil interferes with the absorption and utilization of fat-soluble vitamins, particularly vitamin A, and its precursor, carotene.[4-14] It appears, however, that not only differences in the effect on vitamin A and carotene but also the amount of mineral oil as well as of the vitamins play important roles.

Mineral oil affects the intestinal absorption of carotene much more than that of vitamin A.[4, 12] The admixture of large amounts of mineral oil to butter fat low in vitamin A results in its deficient absorption[8, 9, 13] while with adequate vitamin A administration its absorption was within normal limits. The growth of rats showing signs of depletion of vitamin A is resumed if they receive 2 to 6 International Units of vitamin A in 0.5 cc. of mineral oil as well as if it is administered in the same amount of cottonseed oil.[12] Moreover, in animals on a diet adequate in vitamin A, mineral oil does not affect the growth curve until large doses are given.[5] Furthermore, it has been noted[15] that the plasma carotene shows only a moderate decrease, whereas the plasma vitamin A shows none if mineral oil was given as such or in the form of mayonnaise to normal subjects on a normal unrestricted diet. The significance of the time and mode of administration is indicated by several reports. For instance, no abnormal decrease in the plasma vitamin A level was noted when

30 cc. of mineral oil were taken at bedtime on a diet containing 4,000 units of vitamin A[16] and also only a slight loss of vitamin A occurs if butter fat with the minimal level of vitamin A and mineral oil are fed separately.[11] The influence of the vitamin A concentration in the diet upon the plasma vitamin A level has been studied repeatedly but probably the most complete investigation has recently been reported by a British group studying under the sponsorship of the Medical Research Council.[17]

MATERIAL AND METHODS

Patients who came to the hospital because of some external—usually orthopedic—conditions, but who had no gastrointestinal, liver, renal, pulmonary or cardiovascular disease, were for several weeks put on a standard diet containing established amounts of vitamin A (mostly carotene) varying from 1500 to 3000 I.U.

The proper preparation and intake of the diet was controlled by a special dietitian. During the observation period the plasma vitamin A and carotenoid levels were determined twice weekly by the method of Kimble[18] using the Coleman spectrophotometer. The results were expressed in micrograms per 100 cc.* Subsequently these or other patients were kept for similar observation periods on a diet with controlled vitamin A potency and received in addition variable amounts of mineral oil at various times of the day, sometimes mixed with food and sometimes in its natural form. In some instances mineral oil was discontinued for a period of four weeks and the patient observed again on diet alone.

In toto, the study included 115 experimental periods of 3 to 4 weeks each, on 66 patients. Of these experimental periods, 49 were on basal diets and 66 on basal diets plus mineral oil. Some of the patients had up to 5 consecutive experimental periods.

RESULTS

Influence of vitamin A content of diet on plasma vitamin A level

During the intake of a diet containing 2500 I.U. of Vitamin A, the plasma vitamin A level remained fairly constant as indicated from the averages in Figure 1. In contrast, prolonged intake of a diet containing 3,000 I.U. of vitamin A caused the plasma vitamin A level to rise slightly whereas the intake of 1500 I.U. of vitamin A for a similar period depressed the vitamin A level. The drop on the 1500 I.U. diet with the subsequent rise on the 3,000 I.U. diet is illustrated in Figure 2. The carotenoid levels, in contrast, did not show significant fluctuations. From these studies, it appeared advisable to

* In the tables and graphs the bi-weekly examinations were averaged, as a rule.

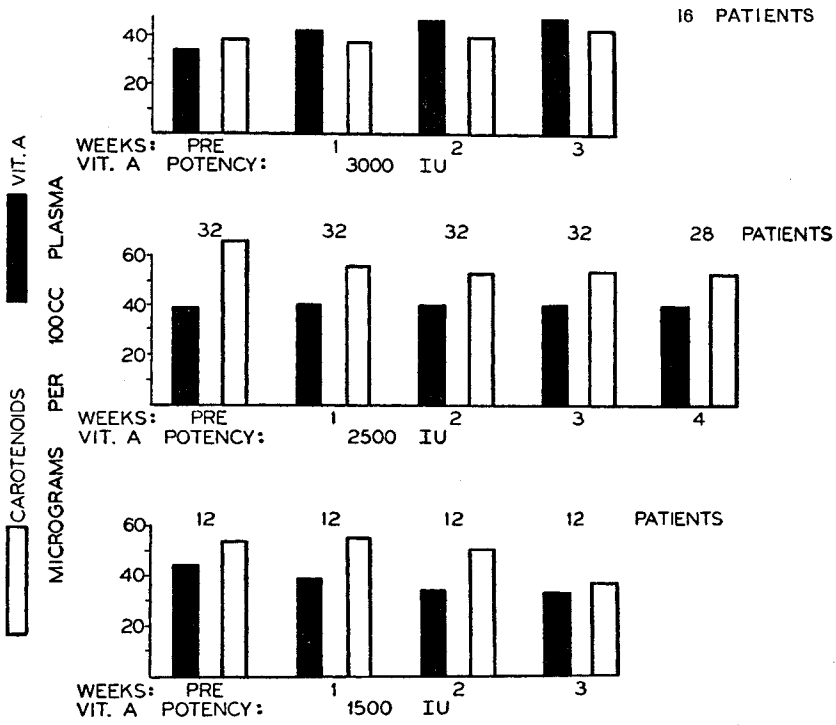

FIG. 1. Average plasma vitamin A and carotenoid levels determined at weekly intervals in patients on diets containing different amounts of vitamin A.

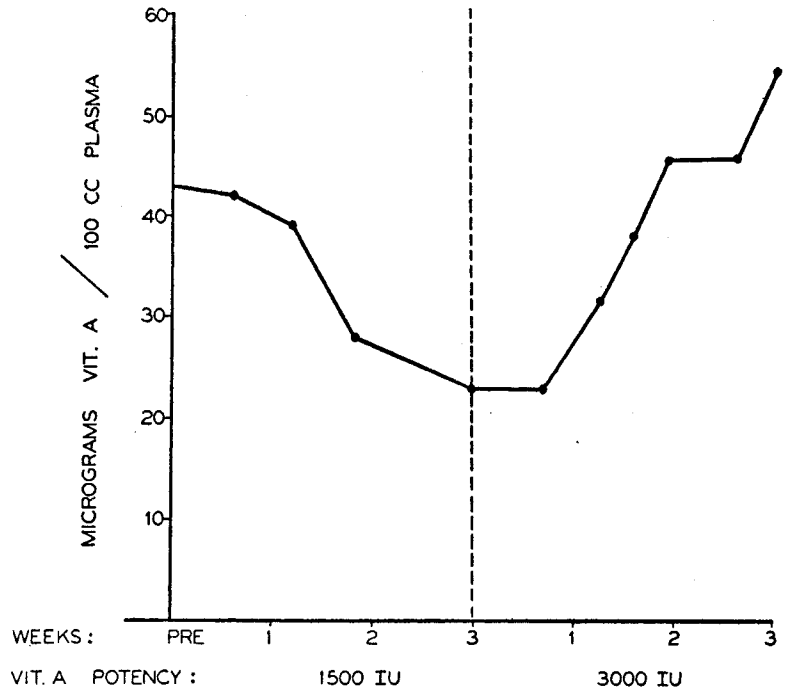

FIG. 2. Decrease in plasma vitamin A level on a diet containing 1500 I. U. vitamin A and marked rise of the plasma vitamin A level when the diet was changed to contain 3000 I. U. vitamin A.

take a vitamin A intake of 2500 I.U. as a base line for the study of the effect of mineral oil.

Influence of the intake of mineral oil upon the plasma vitamin A level

If a standard diet with a vitamin A potency of 2500 I.U. was given, the administration of 30 cc. of mineral oil mixed into the food during the noon meal (corresponding to 6.8% of the food on weight basis for the respective

TABLE I

Effect of mineral oil ingestion on means of plasma vitamin A and carotenoid levels

AMT. OF VIT. A IN DIET	NO. OF PTS.	AMT. AND TIME	MODE OF ADM.	AVERAGE PLASMA LEVELS IN MICROGRAMS PER CENT									
				Pre		1st Week		2nd Week		3rd Week		4th Week	
				Vit. A	Carot.	Vit. A	Carot.	Vit. A	Carot.	Vit. A	Carot.	Vit. A	Carot.
2500	18	30 cc. noon	mix. with food	47	57	44	38	39	35	39	36	37	41
2500	10	30 cc. bed time	given as oil	42	51	42	54	43	50	44	46	38	50
2500	2	10 cc. t.i.d.	mix. with food	44	52	35	46	33	38	30	46	26	30
2500	14	5 cc. t.i.d.	mix. with food	43	66	39	46	38	41	34	45	35	44
2500	8	2½ cc. t.i.d.	mix. with food	30	63	31	59	31	56	33	55	29	53
2500	2	5 cc. noon	mix. with food	42	29	42	32	49	39	45	43	52	30
3000	4	30 cc. noon	mix. with food	42	38	38	23	33	18	31	20		

meal), was associated with a slight but steady drop of the average of the plasma vitamin A level during 4 weeks of administration (Table I). At the end of this period, the average plasma vitamin A level was 10 micrograms below the previous period. This was in contrast to the result obtained when the same amount of mineral oil (30 cc.) was given in the form of oil at bedtime, independent of meals, when the average plasma vitamin A level did not drop. If 10 cc. of mineral oil was given mixed into the meal in three divided doses (with breakfast, lunch and dinner, corresponding to 2.8, 2.3, and 2.2% respectively), the drop was even more marked. If the amount of mineral oil was cut in half and 5 cc. of mineral oil was given, mixed in the food at break-

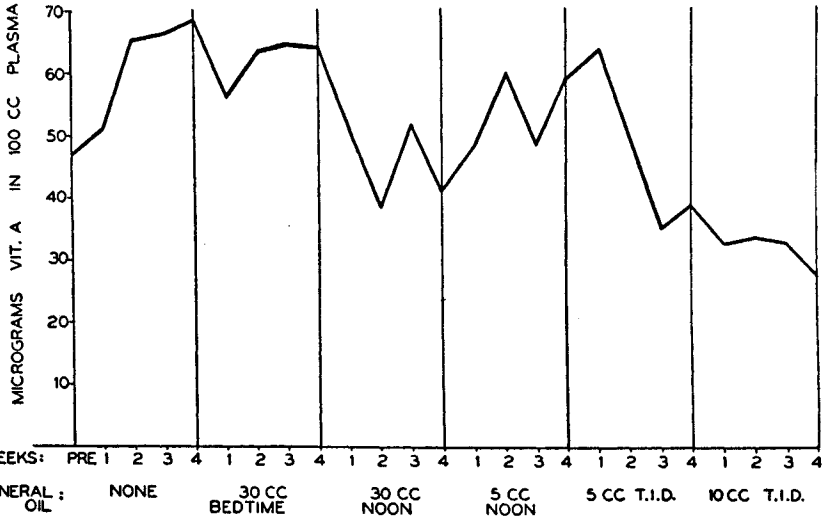

FIG. 3. Average weekly vitamin A levels in a representative case during 5 consecutive experimental periods.

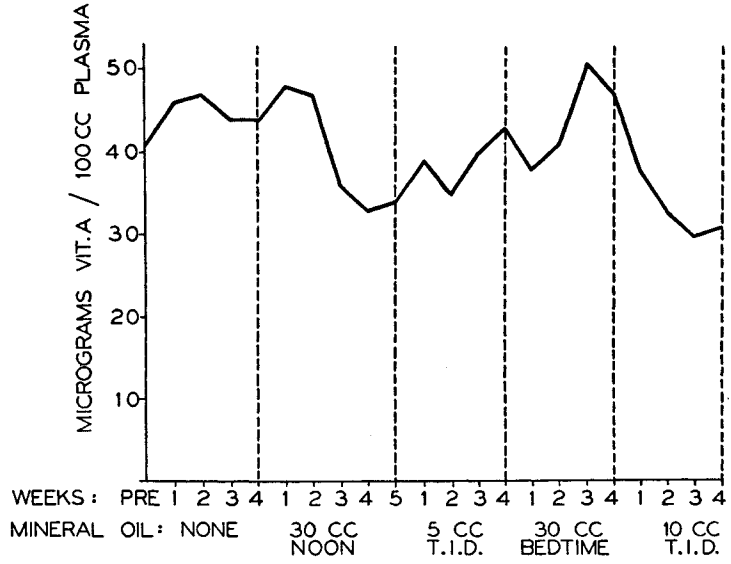

FIG. 4. Average weekly vitamin A levels in a representative case during 6 consecutive experimental periods.

fast, lunch, and dinner, (corresponding to 1.4, 1.1, and 1.1% respectively), a slight but progressive drop of the average plasma vitamin A level was noted, somewhat similar to that when the double amount, namely 30 cc. of mineral oil was given mixed into the food at the noon meal. Administration of 2.5 cc. of mineral oil t.i.d. mixed into the food at breakfast, lunch and dinner

(corresponding to 0.7, 0.6, and 0.5% respectively), was not associated with a significant alteration of the plasma vitamin A level. The administration of 5 cc. of mineral oil mixed into the noon meal (corresponding to 1.1%) was also not accompanied by any alteration. If 30 cc. of mineral oil were mixed into the noon meal of a diet containing a vitamin A potency of 3,000 I.U. (corresponding 6.8%), the average of the plasma vitamin A level dropped similar to that on the 2500 I.U. diet.

In all instances a moderate degree of reduction of the average carotene level was noted. However, the fluctuations were too marked to draw valid conclusions. The results in individual cases in which several regimes followed each other are given in Figures 3 and 4.

DISCUSSION

The preliminary investigations as to the effect of diet on the plasma vitamin A level indicate a fair consistency of the level over several weeks if a diet with a vitamin A potency of 2500 I.U. is given. Most of the vitamin A in the diet is in the form of carotene. This level of 2500 I.U. seems to be a critical level since with the administration of 3000 I.U. the plasma vitamin A level, as a rule, rises significantly, whereas with diets of 1500 I.U., the level drops. This permits, at least under the given experimental circumstances, the use of the plasma vitamin A level as an index of deficiency in vitamin A absorption because, obviously, removal of a significant amount of vitamin A or carotene by administered mineral oil should result in a drop of the level. Obviously, this drop of the vitamin A level may be produced just as well by extraction of carotene from the diet as of vitamin A. The level of the plasma carotenoid was not considered as a critical index because it underwent greater fluctuation. Moreover, chemically, the carotenoid determination does not measure a biologically active principle but rather a mere pigment in the serum. Nevertheless the carotenoid determinations, in general, confirmed the observations obtained with the plasma vitamin A level.

Since the plasma vitamin A level cannot be the same in all subjects examined, it was considered expedient to present average determinations with curves in individual cases (Figures 3, 4).

In confirmation of the previously listed observations, administration of mineral oil did reduce the vitamin A level significantly during the experimental period and it can be concluded that a significant amount of administered vitamin A or carotene (probably more of the latter in view of the diet given) is prevented from being absorbed. On the critical diet of 2500 I.U. and even on the diet with 3000 I.U. Vitamin A potency, probably around 50 per cent of vitamin A or carotene can be prevented from being absorbed as concluded from the plasma vitamin A curve which simulated that on a diet of 1500 I.U. vitamin A potency.

There is, however, a critical level below which the administration of mineral oil appears without effect upon the vitamin A and carotene absorption, at least under the present experimental circumstances. This level, however, depends upon the time and mode of administration. If the mineral oil is mixed with the food as it would be if given in a meal, e.g. as mayonnaise or lubricants, the administration of 2.5 cc. with each meal appears innocuous, whereas administration of 5 cc. or more leads to significant alteration of the plasma vitamin A level, to be interpreted as faulty absorption. If the mineral oil is given only once daily, e.g. at the noon meal, even 5 cc. is innocuous.[19] In contrast, if mineral oil is given in medicinal form as a laxative at bedtime, independent of the evening meal, a dose of 30 cc. was without influence[20, 21, 22] though the same dose given in the meal at noon leads to a moderate decrease of the plasma vitamin A level and if given divided and mixed with breakfast, lunch and dinner, a very marked drop of the vitamin A level resulted.

From these studies it appears that the therapeutic administration of the usual dose of mineral oil, even over prolonged periods has no influence on the vitamin A absorption, and administration of mineral oil in the meals is innocuous if a critical level is not exceeded.

SUMMARY

In order to evaluate the effect of the administration of mineral oil in different doses and in different modes on the absorption of vitamin A and carotene, the plasma vitamin A level and carotenoid level was followed during experimental periods of four weeks on a borderline vitamin A diet on which the plasma vitamin A level remains fairly constant. The study was based on 66 patients for 115 periods.

1. On a diet containing a vitamin A potency of 2500 I.U. (given mostly in the form of carotene) the average of the vitamin A levels remained constant, whereas on diets containing 1500 I.U. a significant drop of the average levels was noted, and on diets containing 3000 I.U. the level, if anything, showed a tendency to rise.

2. On a 2500 I.U. vitamin A potency diet, administration of 30 cc. of mineral oil mixed into the noon meal (6.8%) led to a drop of the plasma vitamin A level whereas 5 cc. (1.1%) were without effect.

3. Ten cc. of mineral oil t.i.d. mixed into breakfast, lunch and dinner was associated with a marked drop of the vitamin A level. Five cc. given similarly was associated with a moderate drop, whereas 2.5 cc. was not associated with any decrease.

4. On a diet containing 3000 I.U. of vitamin A, administration of 30 cc. of mineral oil with the meal also reduced the plasma vitamin A level.

5. Thirty cc. of mineral oil, the usual therapeutic dose given at bedtime independent of meals, was without effect.

6. The previously reported interference with absorption of vitamin A or carotene by administration of mineral oil close to mealtimes has been confirmed. However, the presence of a critical level has been demonstrated (2.5 cc. t.i.d.) below which this interference appears insignificant.

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