



FIGURES 3 AND 4. Passage of solid particles is observed especially in the zone of epithelial desquamation and also between the villi. First the particles are localized in the subepithelial layer (so-called Gruenhagen's space), then they are taken up from the lymph and blood vessels.

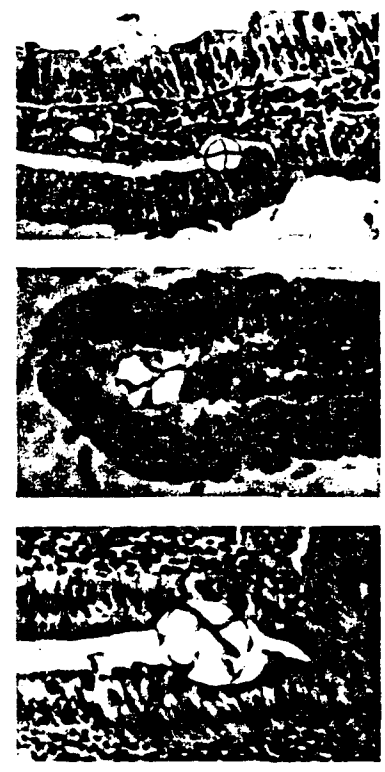


FIGURE 4.

first peak is obtained after 10 min. At this stage there are about 70 particles in 10 ml of venous blood after 200 g of particles in water were consumed. A second peak is reached after about 90–120 min (FIGURE 8).

There were differences in this series of experiments according to whether 100 or 200 g of particles were consumed (FIGURE 9). During physiological sleep higher rates of persorption are seen than during the day. Younger subjects show a higher rate of persorption than older ones. The rate of persorption is increased after injection of prostigmine. Atropine significantly reduces the rate. The rate of persorption is increased after caffeine and after coffee and extremely increased after smoking cigarettes. Further studies were made on how long persorbed particles remain in the blood. After a single administration only very few particles are found in the peripheral blood after 12 h. After 24 h they have usually all disappeared. The bigger ones disappear first (FIGURE 10).

Through the bloodstream persorbed particles are disseminated. Bigger particles are found in tissue and in organs, temporarily embolizing smallest vessels (FIGURE 11). In the liver of rats peaks of PVC particles are seen 2–3 and 10 min after esophageal administration of PVC particles. When starch particles are

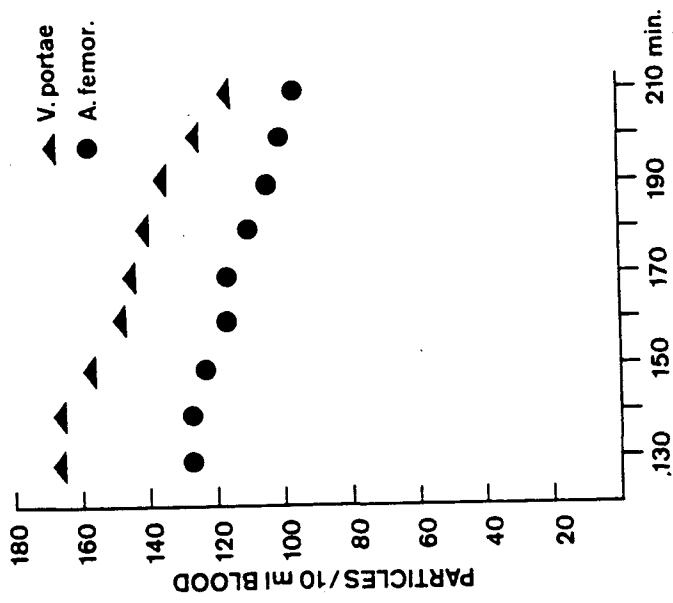


FIGURE 5. After particles were fed to dogs, significantly more particles are found in the portal blood than in arterial blood taken simultaneously. This observation confirms the primary portal transportation of persorbed particles and is the reason why orally administered particles are found in the liver a few seconds after intake.



FIGURE 6. Some kinds of PVC particles are easy to identify on account of their superficial structure and therefore are very suitable for persorption observations (PVC SP Schkopau).



FIGURE 7. In sediments of body fluids (blood, bile, urine, cerebrospinal fluid, etc.) PVC particles are easy to identify on account of their superficial structure.

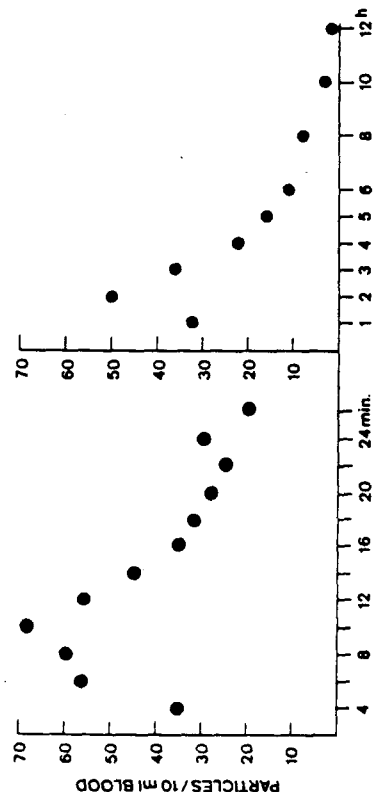


FIGURE 8. After oral administration of particles (200 g of starch particles) in man, within about 1 min the first particles can be found in the venous blood. A first peak is obtained after about 10 min and a second peak after 90-120 min.

administered to cholecystectomized patients the first particles appear in the bile (T-drain) within a few minutes and a maximum is reached after 12 min.

Elimination of persorbed particles took place in the urine, the pulmonary alveoli, the peritoneal cavity, the cerebrospinal fluid, and the milk in animals and

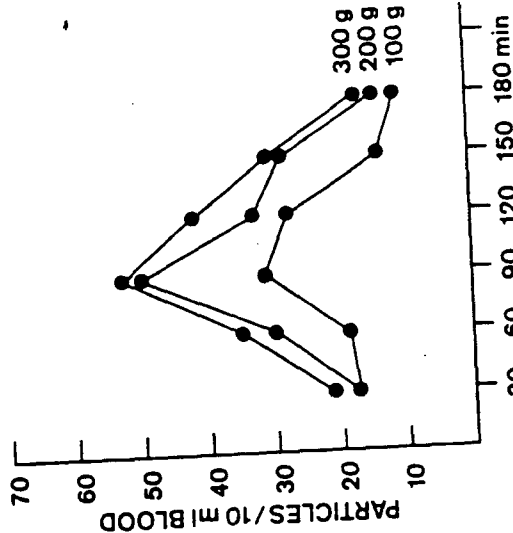


FIGURE 9. After intake of 200 g of particles (2.4×10^8 starch particles) significantly more particles are found in the blood of man 90 min later than after intake of 100 g of particles. However, higher quantities do not increase the rate of persorption significantly. This observation shows that the possibilities of persorption on the intestinal wall are limited.

POTATO STARCH /BLOOD

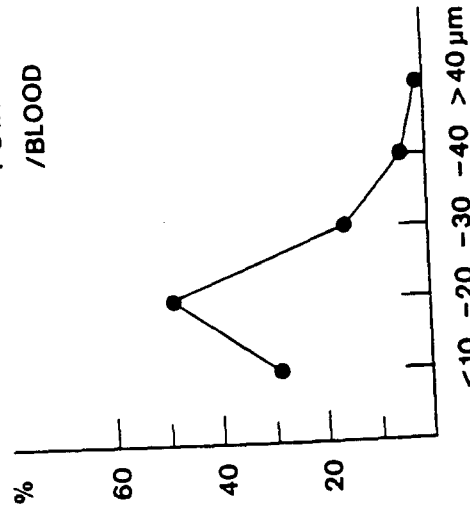


FIGURE 10. Size distribution of persorbed particles in venous blood of human subjects after intake of starch particles. In comparison to FIGURE 1, this figure shows that bigger particles disappear first.

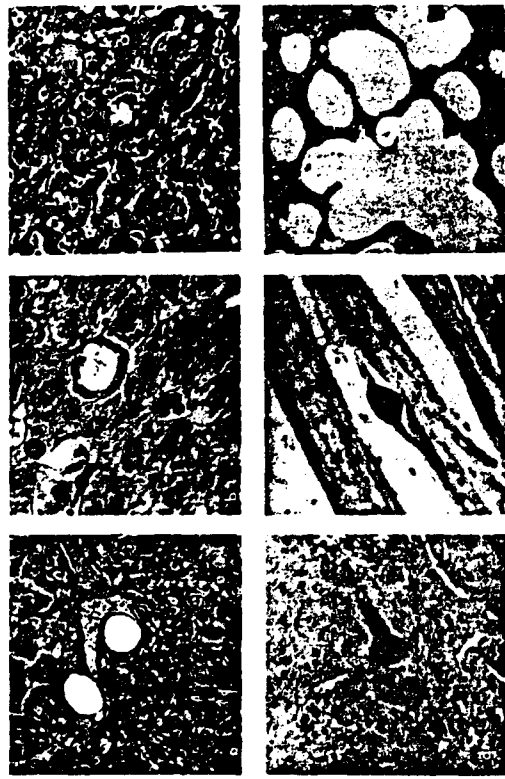


FIGURE 11. In experimental studies of temporary embolizing particles in the liver of rats: no reaction around embolized particles 3 min after feeding (a); endothelial cell formation around the embolized particle after 30 min (b); cellular reactions around the particle after 300 min (c). Embolization of particles is easy to study in the brain (d), the muscle (e), and the pulmonary vessels (f).

in lactating women. Also transplacental passage of PVC particles was confirmed.*

Deposition of embolized PVC particles in the lumen of smallest vessels was observed in animals after long term oral administration. In pigs, dogs, chickens, and rats fed PVC particles individual particles were found for a long time later.

SUMMARY

Persorption of large, hard, insoluble, solid particles in micrometer size range is observed with regularity. It is a normal biological effect on the food passage through the intestine. Persorbability of particles is determined by the size of the particles and by their consistency and hardness. PVC particles in micrometer size range are very suitable as models to study persorbability in animals and the hematogenous dissemination of PVC particles. After oral administration of PVC particles to animals, many PVC particles can be found in the blood. Through the bloodstream they are disseminated in all organs, where individual particles can be found for a long time later.

REFERENCES

1. VOLKHEIMER, G., F. H. SCHULZ *et al.* 1968. Persorption of particles. *Digestion* 1: 78-80.
2. VOLKHEIMER, G., H. WENDLANDT *et al.* 1968. Beobachtungen zum Persorptionsmechanismus. *Pathol. Microbiol.* 31: 51-58.
3. VOLKHEIMER, G. 1972. Persorption. Georg Thieme Verlag, Stuttgart, Germany.
4. VOLKHEIMER, G. & H. JOHN. 1962. Diaplazentarer Uebertritt grosskorpulärer Elemente. *Zentr. Gynaekol.* 84: 1529.
5. VOLKHEIMER, G., F. H. SCHULZ *et al.* 1969. Persorbed food particles in the blood of new-borns. *Gynaecologia* 168: 86-92.

6. VOLKHEIMER, G. 1961. Zur Resorption korpuläcker Elemente durch die Darmschleimhaut und deren Ausscheidung durch den Harn. *Deut. Gesundheitswes.* 16: 1612.
7. VOLKHEIMER, G., F. SZARVAS *et al.* 1961. Aufsaugung von Polyvinylchlorid-Pulver durch die Duendarmschleimhaut und deren Abtransport durch die Chylusgefässe. *Deut. Gesundheitswes.* 16: 1727.
8. VOLKHEIMER, G. 1962. Durchlässigkeit der Darmschleimhaut fuer grosskorpuläcker Elemente. *Gastroenterologia* 97: Suppl., 1883.
9. VOLKHEIMER, G. 1964. Durchlässigkeit der Darmschleimhaut fuer grosskorpuläcker Elemente. *Z. Gastroenterol.* 2: 57-64.
10. VOLKHEIMER, G. & F. H. SCHULZ. 1968. Persorption of vegetable food particles. *Qualitas Plant. Mater. Vegetabilis* 17: 17-30.
11. VOLKHEIMER, G. & F. H. SCHULZ. 1968. The phenomenon of persorption. *Digestion* 1: 213-218.
12. VOLKHEIMER, G., F. H. SCHULZ *et al.* 1969. Effect of caffeine on the rate of persorption. *Nutr. Dieta* 11: 13-22.
13. VOLKHEIMER, G., F. H. SCHULZ *et al.* 1969. Persorption of metallic iron particles. *Gut* 10: 32-33.
14. VOLKHEIMER, G., H. HERMANN *et al.* 1964. Ueber Resorption und Ausscheidung von intakten Hefezellen. *Zentr. Baktiol. I. Orig.* 192: 121-125.
15. VOLKHEIMER, G., F. H. SCHULZ *et al.* 1968. Primary portal transport of persorbed starch granules from the intestinal wall. *Med. Exp.* 18: 103-108.
16. VOLKHEIMER, G., F. H. SCHULZ *et al.* 1968. The effect of drugs on the rate of persorption. *Pharmacology (Basel)* 1: 17-23.