a pressure maximum to occur within the zone in which depletion has occurred.

Between the inflow face and the pressure maximum a hydraulic countercurrent moves toward the inflow face along the central portion of the pores, while the electroosmotic flow occurs at the periphery. Between the outflow face and the pressure maximum, hydraulic flow and electroosmotic flow are in the same direction. In both cases the net flow is the same.

If the plug lacks homogeneity or if the solution in the electrode compartments is not one that would be in equilibrium with the original pore water, or if other conditions are altered, a variety of stress conditions may be induced in the pore water, including pore-water tensions (*3*). The point to be made at this time is that, even when the electrode compartments are flushed with a solution that is nominally in equilibrium with the pore water, initiation of electroosmotic flow induces processes that destroy the initial homogeneity of the pore water, distorting the applied electric field, altering the zeta potential, and confounding hydraulic and electroosmotic flow. The system is simply defined only at zero time, and measurements should be interpreted on this basis.

Zeta potentials computed by conventional methods from measurements of electroosmosis may be in error if it is assumed that the composition and pressure of the pore water remains unaffected by the process.

A more detailed analysis of electroosmotic flow in clay soils, together with pertinent experimental data, is in preparation (*4*).

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9 May 1955

Serotonin Release as a Possible Mechanism of Reserpine Action

Previous communications have reported certain similarities in the physiologic actions of reserpine, a tranquillizing agent, and serotonin (5-hydroxytryptamine), a substance postulated to have a role in brain function (*1*). Both compounds show sedative effects in mice and potentiate the action of certain hypnotics by a central mechanism (*2*). The potentiation caused by either substance is antagonized by pretreatment with lysergic acid diethylamide (*3*), a compound that blocks the effects of serotonin on smooth muscles (*4*) and produces psychotic states in man (*5*).

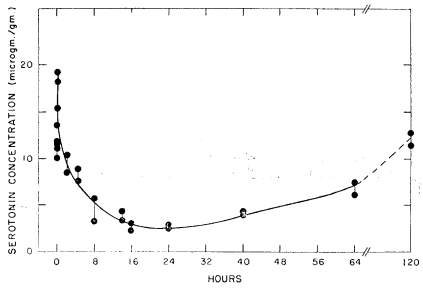

Fig. 1. Serotonin concentration in small intestine at various times after administration of reserpine. The points at zero time denote serotonin concentration in controls. The other points denote the serotonin concentration after administration of reserpine (5 mg/kg) to rabbits intraperitoneally (100 mg of reserpine was dissolved in a few drops of glacial acetic acid and diluted with 4 ml of propylene glycol, 4 ml of ethanol, and 8 ml of water).

It was also demonstrated that administration of relatively large doses of reserpine to dogs markedly increases the urinary excretion of 5-hydroxy-indoleacetic acid (*3*), a major metabolite of serotonin (*6*). These observations suggested that certain actions of reserpine are mediated through liberation of serotonin (*3*). The present communication describes experiments that show by direct analysis that reserpine effects the release of serotonin from the intestine, a major depot of serotonin in the body.

Rabbits received 5 mg/kg of reserpine intraperitoneally. Untreated rabbits served as controls. At various times after drug administration, animals were killed and 10 g of small intestine adjoining the stomach was removed, cut open, and washed with isotonic saline. The tissue was homogenized in 2 vol of 0.2*N* HCl, and the serotonin in the homogenate was measured by modification of the method of Udenfriend *et al.* (*7*). This method involves extraction of the serotonin into butanol, reextraction into dilute acid, and the formation of a colored derivative by reaction with α-nitroso-β-naphthol and nitrous acid. Application of the method to intestinal tissue disclosed the presence of a small amount of interfering material that also reacted with the nitrosonaphthol reagent. The interfering color was removed by shaking the solution of colored products with butanol.

Serotonin content of the small intestine declined progressively for about 16 hr after reserpine administration, finally reaching a concentration 15 to 20 percent of that of the average normal value (Fig. 1). The concentration of serotonin remained at this low level for about 16 hr and then increased slowly, reaching the normal value after about 5 days.

The apparent serotonin in the tissue appeared to be identical with authentic serotonin as shown by comparison of fluorescence spectra (3*N* HCl) using a spectrophotofluorometer previously described (*8*), and by comparison of the absorption spectra of the nitrosonaphthol reaction products. In addition, on chromatographing the intestinal extract on paper (*n*-butanol-1*N* ammonia), the major amount of material fluorescing in acid and forming a blue color with *p*-dimethylaminobenzaldehyde showed the same R_f value as serotonin.

The effect of various doses of reserpine on the content of serotonin in small intestine was determined. As the dose was reduced, the decline in serotonin became gradually smaller but seemed evident with as little as 0.25 mg/kg of reserpine (Fig. 2).

The serotonin content of the whole intestinal tract was determined following the administration of reserpine. In three untreated rabbits, weighing about 2 kg each, the intestines contained an average of approximately 1000 μg of serotonin. Sixteen hours after the administration of 5 mg/kg of reserpine, the content of serotonin in the intestines of three animals averaged 350 μg. Thus the reserpine had caused the liberation of about 650 μg of serotonin from this tissue.

A number of rabbits, especially those given the larger doses of reserpine, had diarrhea. Consequently, the effect of laxatives in purgative dosage (castor oil and magnesium sulfate) and of a cholinergic agent (prostigmine 0.3 mg/kg in three divided doses) was determined. These substances did not change the serotonin content of the intestine. Sedation per se did not effect serotonin release, since heavy barbital and phenobarbital narcosis for 12 hr failed to lower the serotonin content of the intestines.

Experiments described in this paper

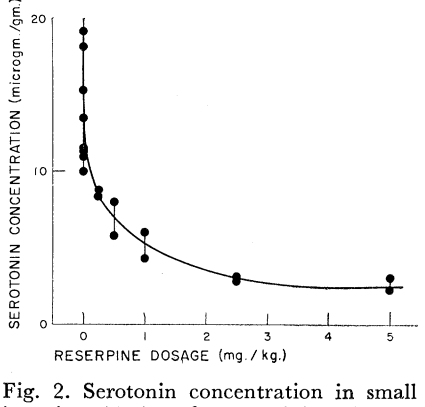

Fig. 2. Serotonin concentration in small intestine 16 hr after administration of various doses of reserpine.

are compatible with the view that some of the central effects of reserpine are mediated through the release of serotonin. It is conceivable that the beneficial effects of reserpine in mental disturbances result from the liberation of serotonin. The possibility that reserpine also affects the level of serotonin in brain is now under investigation.

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25 May 1955

Burger Triangle as a Method for Correcting Inaccuracies of Einthoven Triangle

The triangle of Burger and van Milaan (*1*) was constructed on the basis of the lead vector concept. Burger and van Milaan demonstrated that, in contrast with the triangle of Einthoven, their triangle is accurate for calculating cardiac vectorial directions in the frontal plane of a human phantom, regardless of thorax form, tissue nonhomogeneity, and eccentricity of the assumed resultant heart vector. The shape of the Burger triangle is determined by these factors; the three sides are usually unequal (though the influence of the dispersion of the electromotive forces of the heart is not considered in their concept). To use such a triangle it is necessary, before beginning the usual procedure, to divide the deflections written in the classic limb leads by the length of the corresponding sides. Subsequent studies (*2–8*) suggest that the Burger triangle may prove to be more valuable in clinical electrocardiography than the Einthoven triangle.

The present communication demonstrates the relationship between the shape of the Burger triangle and the inaccuracy of the Einthoven triangle in the calculation of the vectorial directions in the frontal plane. A Burger triangle from a given subject (human or animal, living or dead, or electrolytic model) could have one of three shapes: equilateral, isosceles, or scalene. If it is equilateral, which is exceptional, the Einthoven triangle is obviously accurate. If it is not equilateral, the Einthoven triangle is inaccurate. But isosceles or scalene triangles can have various accentuations and departures from the equilateral triangle.

Figure 1 shows four hypothetical Burger triangles from four subjects; *a* and *b* are isosceles, whereas *c* and *d* are scalene. But *b* and *d* depart more from the equilateral than do *a* and *c*. For convenience, a Burger triangle may be transformed to a triaxial reference system (just as the Einthoven triangle has been transformed to the triaxial reference system of Bayley) with parallel transposition of the three sides of the Burger triangle toward its geometric center until they coincide. In the same figure four triaxial reference systems—transformed from Burger triangles *a, b, c,* and *d,* respectively—are shown.

We may designate *l, m,* and *n* as the lengths of the lead vectors *RL, RF,* and *LF* of a Burger triangle; and p_1, p_2, and p_3 as projections of the heart vector upon *l, m,* and *n*. On the basis of the concept that the deflection of an electrocardiographic lead equals the scalar product of heart vector and the lead vector, one gets

$$L_I = lp_1,\ L_{II} = mp_2;\ L_{III} = np_3$$

In order to demonstrate the relationship between the Burger triangular shapes in Fig. 1 and the inaccuracy of the Einthoven triangle, it is necessary to assume the heart vector to be of equal length in the same arbitrary direction, V (+45°), in each case. From the terminus of V in each triaxial reference system, perpendicular lines to three sides were drawn; p_1, p_2, and p_3 were measured. From the equations, the deflections in L_I, L_{II}, and L_{III} were calculated. The values were used to plot the vectorial direction for each subject in the triaxial reference system of Bayley (Fig. 2). The directions *a, b, c,* and *d* correspond to subjects with Burger triangles *a, b, c,* and *d,* respectively. It may be observed that they deviate from V (the arbitrary "true" direction); that $\angle boV$ is larger than $\angle aoV$, and that $\angle doV$ is larger than $\angle coV$.

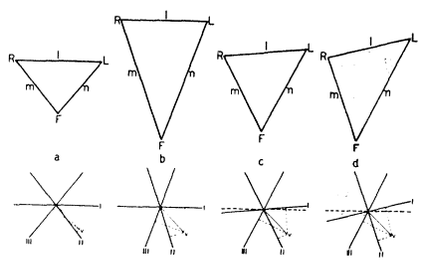

Fig. 1. Four hypothetical Burger triangles and corresponding triaxial reference systems. V is the arbitrarily true heart vector, which is assumed to be the same in each case.

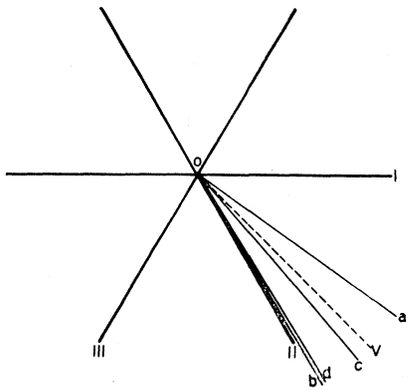

Fig. 2. The triaxial reference system of Bayley showing the directions of V and the calculated vectors.

The Einthoven triangle is inaccurate for subjects possessing Burger triangles either of isosceles or scalene shape. The more the triangle departs from the equilateral, the more the vectorial direction, calculated in the Einthoven triangle, deviates from the true one. Use of the Burger triangle permits correction of these potential errors.

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14 April 1955

Photochemical Activity of Chloroplasts Isolated from Sugar Beet Infected with Virus Yellows

Sugar beet virus yellows is a serious disease in Europe, where even the mild forms can reduce sugar yields by more than 20 percent (*1*). The disease now appears to be widespread in the western United States. Watson and Watson (*2*)