

The Permeability of the Synovial Membranes.

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Little is known of the physiology of the synovial membranes, particularly regarding their permeability. As a consequence, it is difficult to understand the effusions occurring in joint cavities, or the accumulations of fluid in tendon sheaths and in bursae, consequent to trauma or disease. The knee joint is usually studied since it is easily accessible. In addition, it possesses the most extensive synovial membrane in the body. Diffusible constituents pass readily from the blood into the synovial fluid. In fact Crouter, Cajori and Pemberton¹ have shown that their concentration in synovial fluid can be readily changed by inducing corresponding changes in the blood. Fisher² observed that potassium iodide, Berlin Blue, and colloidal silver were absorbed from the knee joints of rabbits. He demonstrated iodide in the urine but did not determine in this manner its rate of absorption from the synovial cavity.

Using the method of Dandy and Rowntree,³ we have studied the permeability of the synovial membrane to phenolsulphonephthalein in 5 male patients with effusion in the knee joint. In 4 this was traumatic in origin; in one it was due to chronic infection. With the patient at rest during the entire procedure, a soft rubber catheter a demeure was first introduced into the bladder. Under strict asepsis and local anesthesia, a large bored needle was then inserted into the joint cavity through the upper and outer portion of the joint capsule. As much as possible of the effusion fluid was aspirated without undue manipulation. This was cultured, injected into guinea pigs and analyzed chemically. The usual amount, 6 mg. in 1 cc., of P.S.P. was then injected into the joint cavity through the aspirating needle. Its appearance time was noted in the urine draining from the catheter, and the catheter was then removed. The urine was voided at the end of the first and second hour, and the amount of dye excreted determined colorimetrically.

The results are presented in Table I. In one patient, with chronic multiple arthritis of 9 years duration, *Streptococcus viridans* was isolated from the synovial fluid. The remaining fluids were sterile

¹ Cajori, Crouter and Pemberton, *Arch. Int. Med.*, 1926, xxvii, 92.

² Fisher, T., *Lancet*, 1923, ccv, 541.

³ Dandy and Rowntree, *Annals of Surgery*, 1914, lix, 587.

to culture and guinea pig inoculation. Chronic infection, in this one instance, did not appear to decrease the permeability; if anything, it increased it. The catheter appearance time of the P.S.P. varied between 9 and 13½ minutes, averaging 11½ minutes in 6 tests. This is slower than that following the usual intravenous or even intramuscular administration. The amount excreted is within the normal range, save in one case in which it is low. In all 5 patients, the urine examinations were negative, likewise the serological tests.

TABLE I. *Permeability of the Synovial Membrane to P.S.P.*

No.	Diagnosis	Date	Amt. cc. withdrawn	Bact'y	P.S.P. app.	P.S.P. 1 hr.	P.S.P. 2 hrs.	Total
917	Chronic Multiple Arthritis	12/ 6/'27	120	<i>Strep. viridans</i>	min. 9	% 40	% 22	% 62
4745	Osteocartilage Loose Body	6/ 6/'28	50		Neg.	12½	25	30
4745	Osteocartilage Loose Body	7/11/'28	90	Neg.	12½	27	20	47
8930	Injured Cartilage	12/31/'28	110	Neg.	9	20	15	35
11124	Traumatic Arthritis	4/16/'29	100	Neg.	12	30	26	56
16808	Injured Cartilage	11/ 5/'29	35	Neg.	13½	25	25	50
				Average	11½	28	23	51

As a means of comparison, the permeability of other serous and synovial membranes was similarly studied in 6 other patients. The *tunica vaginalis testis*, the peritoneum, the synovial lining of the

TABLE II. *Permeability of Serous and Synovial Membranes to P.S.P.*

No.	Membrane	Diagnosis	Date	P.S.P. app.	P.S.P. 1 hr.	P.S.P. 2 hrs.	Remarks
980	Tunica Vag. Testis	Hydrocele	12/ 7/'27	10 hrs. (†)	None	—	85% recovered in 16 hrs.
2621	Peritoneum	Ascites of Portal Cirrhosis	3/ 1/'28	2nd hr.	None	3%	5% 3rd hr. 5% 4th hr.
8255	Tunica Vag. Testis	Recurrent Hydrocele	12/ 4/'28	12 hrs. (†)	None	None	Nearly all recovered in 16 hrs. 400 cells per cu. mm.
10287	Synovial Bursa	Prepatellar Bursitis	10/ 7/'29	(†)	None	None	Numerous cells
11064	Synovial Tendon Sheath	Ganglion	4/29/'29	15 min.	40	20	8% excreted first 15 minutes
9869	Pleura	Carcinoma of Breast	1/14/'30	2nd hr.	None	5%	15% in 9 hrs.
		Hydrothorax					

prepatellar bursa, the synovial sheath of one of the dorsal carpal tendons, and the pleura were thus investigated. The results are presented in Table II. In the instance in which there was a possibility of infection, in the case of prepatellar bursitis, the fluid was sterile bacteriologically. The 5 membranes were extraordinarily variable in their permeability. In the case of the tendon sheath the process of absorption was rapid; the P.S.P. appeared in the urine within 15 minutes and 60% was excreted in 2 hours. In the case of the *tunica vaginalis testis*, however, the process was very slow. In fact, little if any of the dye was excreted by the kidney in 12 hours, and nearly all the P.S.P. injected was recovered from the hydrocele sac at the end of 16 hours. This latter observation is being thoroughly studied by Huggins and Entz.⁴

In traumatic arthritis with effusion the synovial membrane of the knee is freely permeable to phenolsulphonephthalein. There is great variability in the permeability of diseased serous and synovial membranes.

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Creatine in Medullated Nerve.

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The finding in frog and rabbit sciatic nerves of a soluble phosphorus compound behaving like the phosphocreatine of muscle¹ suggested the desirability of a similar study of nerve creatine.

Total creatine was determined, after digestion of the whole tissue for 3 hours in $N H_2SO_4$ on a water bath, by the usual picric acid method. For estimating "free" and "bound" creatine, the cold tissue was extracted with iced trichloroacetic, alcohol added to an aliquot portion to a concentration of 66% and the bound creatine precipitated with crystalline $Ba(OH)_2$ (Eggleston,² for separating phosphocreatine). The 2 fractions were then heated with acid and determined as above. Controls showed full recovery of creatine in the "free" fraction and phosphocreatine (kindly supplied by Dr. Fiske) largely in the "bound" fraction.

⁴ Huggins, C. B., and Entz, F. H., personal communication.

¹ Gerard, R. W., and Wallen, J., *Am. J. Physiol.*, 1929, lxxxix, 108.

² Eggleston, P., personal communication.