lactic and Prausnitz-Kustner sensitivities as to indicate that a different and perhaps quite labile antibody must be concerned. The fact that passive transfer of tuberculin sensitivity has been accomplished only with living cells and only after an incubation period of two to three days suggests that the sensitivity may be principally due to antibody elaborated by such cells during their residence in the recipient rather than to preformed antibody.

Summary. Homologous passive transfer of tuberculin sensitivity was accomplished with the peritoneal and splenic cells of guinea pigs infected with the B.C.G. strain of *Mycobacterium tuberculosis.*

The possible mechanism and factors involved in passive transfer of tuberculin sensitivity are discussed.

16023

Effects of X-ray Irradiation on Viscosity of Synovial Fluid.

CHARLES RAGAN, CHARLOTTE P. DONLAN, JAMES A. COSS, JR. AND AUDREY F. GRUBIN.
(Introduced by R. F. Loeb.)

From the Departments of Medicine and Radiology of the College of Physicians and Surgeons, Columbia University, and the Edward Daniels Faulkner Arthritis Clinic of the Presbyterian Hospital, New York.

The treatment of arthritis by X-rays advocated in the European[1] and English[2] literature since 1930 is difficult to evaluate. However, in 1941, Smyth, Freyberg and Peck[3] demonstrated conclusively that a favorable response to X-ray therapy is obtained in ankylosing spondylitis. Many confirmatory reports have followed this observation.[4] The mechanism whereby improvement follows roentgenotherapy in such cases is not apparent.

Recently, two papers[5,6] have appeared describing a reduction in the viscosity of thymonucleic acid after irradiation, depending in degree upon the total X-ray dosage given. This is in agreement with the principles outlined by Colwell[7] in his review of work dating from 1912, to the effect that a diminution in viscosity of organic colloids such as egg-white, serum and starch followed exposure to X-ray. The reason such a change occurs is still not clear. In the case of thymonucleic acid,[6] evidence was presented that the change induced by X-radiation did not involve a splitting of primary linkages or a rearrangement of the configuration which made it susceptible to enzymatic attack.

The viscosity of normal human synovial fluid is very high.[8,9] The viscosity of joint fluids obtained from the knees of patients with rheumatoid arthritis tends to be greater in the chronic than in the acute stage, and to approach the viscosity of normal synovial fluid.[10]

The present study records observations which show that irradiation of joint fluids

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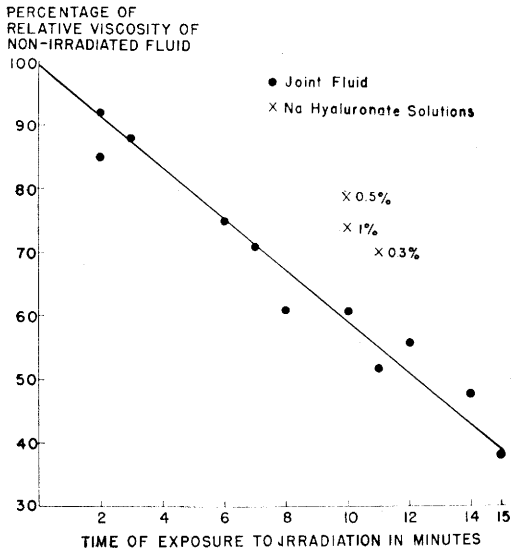

FIG. 1.
Effect of X-ray irradiation on viscosity of joint fluid and Na hyaluronate solutions.

diminishes their viscosity and that the decrease bears a direct relationship to the amount of irradiation.

Methods. Relative viscosity was measured in 5 cc Ostwald viscosimeters in a water bath at 21±1°C. Total protein concentrations of the synovial fluid were determined with a gradient tube method.[9,11] The amount of hyaluronic acid present was measured by a turbidimetric method[12] similar to that described by Seastone.[13] Irradiation was furnished by a Phillips contact machine delivering 9290 r/minute. Material to be irradiated was placed in a 50 cc glass centrifuge tube in contact with the treatment tube of the X-ray machine. The average roentgen delivery to the fluid was 334 r/minute.* Because of the type of irradiation, this estimate is only approximate.

The results of the irradiation of 4 pathological knee joint fluids† are shown in Fig. 1. Their relative viscosities were 214, 59.4, 42.7 and 22.5 x H_2O. When these were plotted against time of exposure, the correlation between the time of irradiation and the percentage decrease in viscosity was good.

The effect of irradiation on solutions of pure sodium hyaluronate‡ of varying concentrations was less than the effect on joint fluid (Fig. I.). Upon irradiation of the pure solutions, no increase in titratable acidity above that of the unirradiated controls was demonstrable, which would imply that there was no oxidative degradation. In irradiated joint fluids, no appreciable decrease in the amount of hyaluronate was detectable turbidimetrically nor was there any change in the total protein content of the fluid (Table I.). A small difference in the enzymatic hydrolysis of the irradiated and control samples was detectable viscosimetrically. The half-time for the irradiated sample was 14.5 minutes, and of the control 17 minutes, when equal amounts (0.05 mg equal to 7 viscosity reducing units) of bull testis hyaluronidase were used. From this one may assume that no profound change in the hyaluronic acid molecule had occurred.

An effort was made to detect the continuing fall in viscosity on standing after irradiation, as described by Taylor *et al.*[6] for thymonucleic acid. Some indication of this was seen in the preparations of pure hyaluronate, but not in the joint fluid preparations.

Discussion. Irradiation causes a decrease in viscosity of joint fluid. It was impossible to determine the exact amount of irradiation delivered under our conditions, but the decrease bore a direct relation to the time of exposure. The manner in which the molecule is changed is not clear from these observations. That purified hyaluronic acid is

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* This was calculated with an ionization chamber in the fluid at 3 sites: 1. Nearest the X-ray tube. 2. In the center of the centrifuge tube. 3. At the side the greatest distance from the X-ray tube. The results of the three readings were averaged.

† Two of the fluids were obtained at different times from a patient with rheumatoid arthritis. One was obtained from a patient with an undiagnosed arthritis of the knees, possibly associated with lymphogranuloma inguinale. One was a pooled sample containing knee joint fluid from several patients with rheumatoid arthritis.

‡ Obtained from Dr. K. Meyer.

TABLE 1.
Effect of X-ray Irradiation on Relative Viscosity, Hyaluronic Acid Concentration, and Total Protein Content of Joint Fluid.

Joint fluid	Time exposed to irradiation (min)	Relative viscosity X H_2O	Total protein, %	Hyaluronic acid (mg per cc)
R.R. of 6/18/46	0	214	4.8	0.24
	2	200	4.9	0.26
	7	151	4.9	0.25
	11	111	4.9	0.24
Pooled	0	22.5	4.9	0.22
	2	19.2	4.9	0.21
	6	16.9	4.9	0.22
	12	12.7	4.9	0.22
R.R. of 3/12/47	0	42.7	5.0	0.16
	3	37.4	5.0	0.16
	8	26.1	5.0	0.16
	14	20.5	5.0	0.16

never as viscous as joint fluid of equal hyaluronic acid concentration[12] has been attributed to the presence of secondary valences in the native material which are broken on purification. The greater susceptibility to irradiation of joint fluid, as compared with that of solutions of hyaluronate, would suggest that these secondary valences may primarily be attacked by the X-rays. The hyaluronic acid in irradiated joint fluid is still susceptible to enzymatic hydrolysis and thus irradiation did not cause a profound change in the hyaluronic acid molecule. Although the amount of irradiation delivered is beyond the physiological range, it is possible, nevertheless, that this effect may be one of the factors which come into play in the response of pathological joints—peripheral and spinal—to irradiation. The widespread presence of the viscous acid mucopolysaccharides of this group throughout the connective tissue of the organism may make this an important factor in the response of many tissues to roentgenotherapy.

Conclusions. 1. The viscosity of joint fluid is decreased by exposure to X-rays, the decrease in viscosity being directly proportional to the amount of irradiation. 2. The viscosity of pure hyaluronic acid solutions is decreased less by the action of X-rays than is the viscosity of joint fluid. 3. Joint fluid is as susceptible to the enzymatic action of bull testis hyaluronidase in the irradiated sample as in the control. No increase in titratable acidity follows irradiation of pure hyaluronate solution, indicating that the reduction in viscosity probably does not result from oxidative degradation. 4. The possible physiological implications are discussed.