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Cholesterol in Human Semen

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1. The cholesterol content of human seminal plasma has been estimated in 200 samples. The mean concentration is 46·8mg./100ml. (S.E.M. ± 1·1, range 15–88). The free cholesterol corresponds to about 40% of the total. 2. Cholesterol in human semen is secreted almost entirely from the prostate gland.

Studying the biochemistry of human semen, Goldblatt (1935) demonstrated a cholesterol content of about 80mg./100ml. Scott (1945), who came to almost the same result, speculated about the origin of cholesterol in semen and proposed that two-thirds came from the seminal vesicles and one-third from the prostate gland. These proportions were calculated from analyses of the cholesterol content in prostate gland, prostatic fluid and seminal plasma.

During recent years the methods for determination of cholesterol have improved significantly. It has also been demonstrated that erroneous results with regard to the source of various compounds in the seminal plasma may be obtained if calculations are based on tissue extracts (Eliasson, 1959, 1964). In the present study the occurrence and origin of cholesterol in human seminal plasma have been studied.

MATERIAL AND METHODS

Semen samples were obtained from volunteers and the Sterility Laboratory of the Karolinska Hospital. Part of each sample was transferred to glass tubes and kept at −20° until analysed, usually within 2 weeks. Before analysis the samples were thawed at room temperature and centrifuged to remove the spermatozoa.

The total cholesterol was determined by the method of van Boetzelar & Zondag (1960). A 5ml. volume of reagents [made by mixing 4·0g. of toluene-*p*-sulphonic acid, 60ml. of acetic anhydride and 40ml. of acetic acid (99–100%), all reagent grade] was transferred to a 50ml. test tube and 1ml. of conc. H_2SO_4 (95–97%, reagent grade) was carefully added. The mixture was cooled to room temperature and 0·2ml. of seminal plasma added. The green colour was measured within 5–30min. at 620mμ against water in a Beckman DB or Beckman B spectrophotometer. Free cholesterol was precipitated by digitonin as described by Sperry & Webb (1950) and determined by the method of van Boetzelar & Zondag (1960). Recovery was studied after the addition of known amounts of cholesterol in acetic anhydride to the seminal plasma. The origin of cholesterol was studied by the 'split-ejaculation method' (for details see Eliasson 1959, 1964).

RESULTS

The accuracy of the method for measuring cholesterol was determined from ten analyses of a pooled semen sample. The standard error of the mean was ±0·3mg./100ml. The mean concentration of cholesterol in 200 samples was 46·8mg./100ml. (S.E.M. ± 1·1, range 15–88mg./100ml.). The recovery of added amounts of cholesterol was 92–94%. Free and total cholesterol were determined in ten randomly selected samples: 41% (S.E.M. ± 1·5) of the cholesterol occurred in the free form.

The origin of cholesterol was studied in 'split-ejaculates' from three volunteers. The results demonstrated that probably all the cholesterol was secreted from the same origin as acid phosphatase, i.e. the prostate gland. The experimental results

Table 1. *Concentration of various constituents in different portions of human seminal fluid*

Fraction no.	Weight (g.)	Acid phosphatase (units/ml.)	Cholesterol (mg./100ml.)	Fructose (mg./100ml.)
A1	0·17	11·330	114	72
2	0·46	3·840	76	205
3	0·35	5·375	80	120
4	0·37	3·650	50	300
5	0·54	2·750	43	312
6	1·35	1·215	30	432
B1	0·82	6·655	96	120
2	0·60	5·120	54	230
3	0·40	3·010	46	250
4	0·44	2·240	40	290
5	0·68	2·495	36	310
C1	1·02	7·680	90	110
2	1·29	1·750	35	495
3	1·43	1·560	25	565

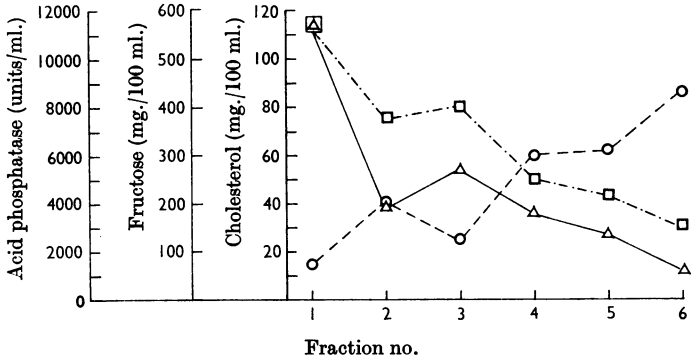

Fig. 1. Distribution of acid phosphatase (△), fructose (○) and cholesterol (□) in a 'split-ejaculate' from a healthy man. The pattern of distribution indicates that cholesterol is secreted from the same organ as acid phosphatase, i.e. the prostate gland.

are given in Table 1 and for one of the subjects in Fig. 1 also.

DISCUSSION

Little information is available on the lipid components in seminal plasma from various mammals. Scott (1945) found a mean content of total lipids corresponding to 186mg./100ml. of human seminal plasma. Cholesterol accounted for about 50–60% of this amount. Goldblatt (1935) found the average cholesterol concentration to be about 80mg./100ml. On the other hand, stallion semen had about the same concentration of lipids as human semen but the cholesterol content was only 4mg./100ml. (cf. Mann, 1964). For other mammals no data seem to be available.

Cholesterol originates most probably entirely from the prostate gland. This finding differs from the proposal by Scott (1945) that the fluid from the seminal vesicles should contain twice as much cholesterol as that from the prostate gland. This proposal was based on analyses of organ extracts.

About 40% of the cholesterol in semen occurred in the free form, a value that corresponds to that for human blood plasma. On the other hand, Scott (1945) reported that he found 90% of the cholesterol in the enlarged prostate gland to be in its free form. There seems to be no value available for the normal prostate gland.

It is known that the spermatozoa can metabolize fatty acids, but lipids themselves do not seem to influence the sperm metabolism (cf. Mann, 1964). It has been suggested that the lipoproteins in semen may act as protective colloids on the sperm cells. The possible significance of cholesterol for the metabolism and fertilizing properties of the spermatozoa is, however, not known.

Swyer (1942) observed that the adenomatous part of hypertrophic prostate glands contained about twice as much cholesterol as did the normal tissue. Nylander (1955) found that the lipid pattern of the semen showed characteristic changes in samples obtained from patients with prostate hypertrophia. It therefore appears that studies on the biochemical composition of human semen may not only be of interest in relation to the reproduction but also of value in diagnosis and evaluation of the pathophysiology of diseases in the male accessory genital glands.

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REFERENCES

Eliasson, R. (1959). *Acta physiol. scand.* **46** (suppl.), 158.
Eliasson, R. (1964). *Nature, Lond.*, **203**, 980.
Goldblatt, M. W. (1935). *Biochem. J.* **29**, 1346.
Mann, T. (1964). *Biochemistry of Semen and of the Male Genital Tract*, pp. 108, 280. London: Methuen and Co. Ltd.
Nylander, G. (1955). *Scand. J. clin. Lab. Invest.* **7**, 250.
Scott, W. W. (1945). *J. Urol.* **53**, 712.
Sperry, W. W. & Webb, M. (1950). *J. biol. Chem.* **187**, 97.
Swyer, G. I. M. (1942). *Cancer Res.* **2**, 372.
van Boetzelar, C. L. & Zondag, N. A. (1960). *Clin. chim. Acta*, **5**, 943.