SEMEN ELECTROLYTES IN NORMAL AND INFERTILE CASES
I. SODIUM, POTASSIUM, CALCIUM AND MAGNESIUM

by

K. P. SKANDHAN,*†[a] M.Sc.

Y. B. MEHTA,**† M.B.B.S., M.Sc.

T. M. CHARY,*‡[b] M.Sc.

and

M. V. S. ACHAR**‡

Introduction

Sheth and Rao (1962) reported higher potassium level in seminal plasma as the cause of less motility of spermatozoa. Experimental studies of Rosado (1970) and Loewit (1971) also show the importance of electrolyte concentration in seminal plasma.

We undertook this study to find out if any change in electrolyte concentration in oligospermic and azoospermic was present. In the present study sodium, potassium, calcium and magnesium were estimated either in semen and/or in seminal plasma.

Material and Methods

All the samples were collected after an abstinence of minimum 10 days. Infertility cases were included either in

1. Oligospermic group, where sperm count was less than 4 million per ml. or 2. Azoospermic group where no sperm was present even after centrifugation.

Semen found normal in all routine examinations and from the subjects with proven fertility was considered as control group. Seminal plasma was separated from whole semen by centrifugation. Totally, 59 normal, 47 oligospermic and 27 azoospermic samples were studied.

Motility of the spermatozoa was seen microscopically and designated as either excellent, fair or sluggish.

Sodium and potassium were estimated by flame photometric method, calcium by the method described by Clerk, and Collip (1925) and magnesium by calorimetric method of Neill and Neely (1956).

Results

The volume of semen varied from 0.5 to 4.5 ml. in study groups and 2 to 5.1 ml. in control group. Motility was branded excellent or fair in all normal and oligospermic groups.

Results are presented in Table 1 and in graphs 1, 2, 3 and 4 for the various groups.

In case of oligospermic semen, we observed increased amount of sodium (< 0.01) (graph 1), slightly elevated calcium (graph 3) and magnesium (graph 4) and no much difference in potassium (graph 2) than normal (Tables 1 & 3). Results of azoospermic semen are given

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*Tutor.

**Professor.

†Dept. of Physiology Govt. Medical College, Surat 395 001.

‡Dept. of Physiology, M. P. Shah Medical College, Jamnagar 362 001.

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(a) Present address: Asst. Prof. in Physiology, B. J. Medical College, Ahmedabad-380 016.

(b) Present address: Asst. Prof. in Biochemistry, B. J. Medical College, Ahmedabad-380 016.

TABLE I

Results of Present Study in mgm%

Group	Semen: Sodium ±SE	Semen: Potassium ± SE	Semen: Calcium ± SE	Semen: Magnesium ± SE	Seminal Plasma: Sodium ± SE	Seminal Plasma: Potassium ± SE	Seminal Plasma: Calcium ± SE	Seminal Plasma: Magnesiom ± SE
Normal	312.26	58.62	31.77	0.952	352.85	56.05	40.3	5.17
	(305.2	(49.92	(14.2	(0.27	(340.4	(50.7	(30.6	(3.41
	—322)	—67.86)	—55.1)	—1.51)	—384.1)	—66.3)	—50.0)	—6.82)
	±2.78	±2.48	±4.09	± .2	±7.11	± 3.13	±4.47	± 0.97
Oligospermic	330.03	59.11	41.41	1.38	340.3	63.89	31.75	3.66
	(305.9	(46.8	(27.5	(0.424	(301.3	(54.6	(24	(1.81
	—368)	—73.5)	—61)	—2.12)	to 363.4)	—74.1)	—37)	—6.06)
	±5.04	±2.6	±9.5	± .8	± 7.6	± 2.6	± 2.9	± .51
Azoospermic					251.63	75.62	44	3.4
					(213.7	(58.5	(40	(1.9
					—279.5)	—85.8)	—46)	—6.3)
					± 5.3	± 4.1	± 1.26	± .66

in Table 1 and 4. A decrease in sodium (< 0.01) (graph 1) and magnesium (graph 4) and an increase in potassium (graph 2) levels are noted; no much change in calcium (graph 3) was seen.

Discussion

Not many reports are available about the electrolytes in semen and/or seminal plasma of man. The electrolyte concentration may vary at different times in the same individual. A frequent ejaculate study done in bull by Cragle *et al* (1958) revealed progressively rising sodium and chloride concentrations and decreasing potassium and calcium. To avoid this type

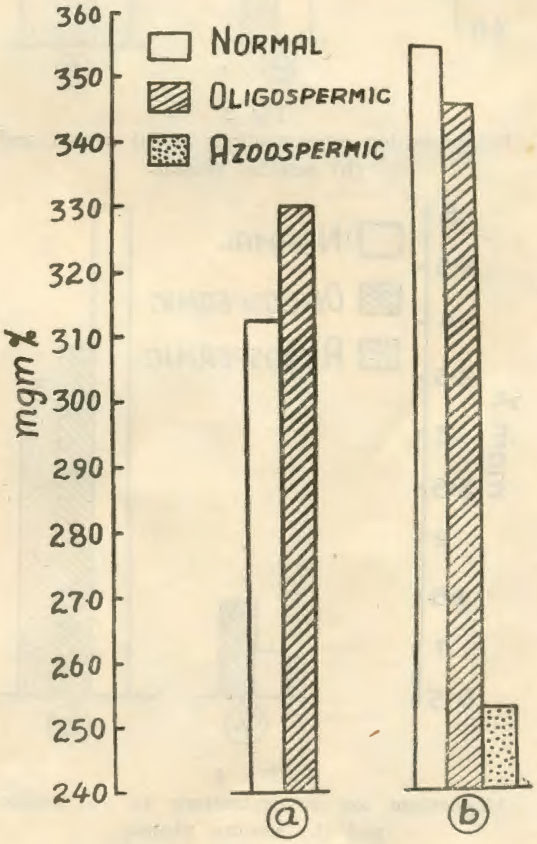

Fig. 1

Sodium ion concentrations in (a) semen, and (b) seminal plasma.

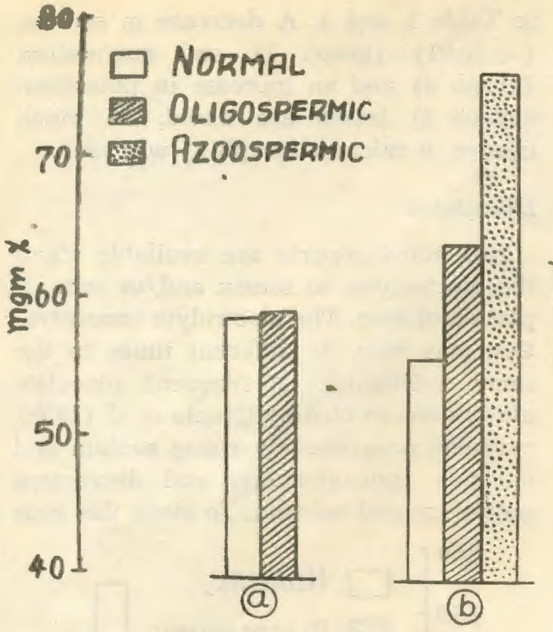

Fig. 2
Potassium ion concentrations in (a) semen, and (b) seminal plasma.

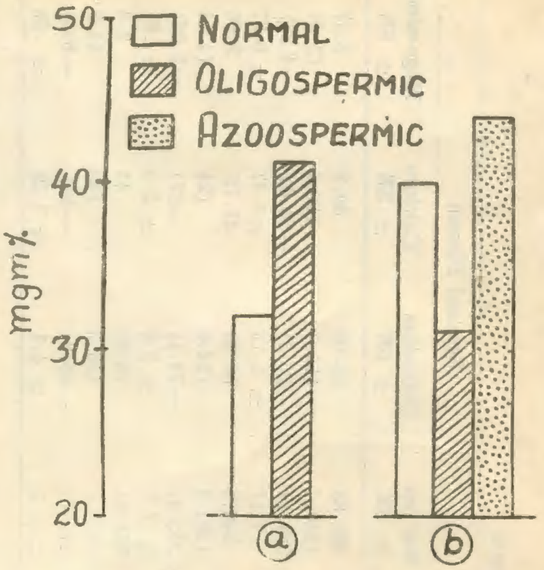

Fig. 3
Calcium ion concentrations in (a) semen, and (b) seminal plasma.

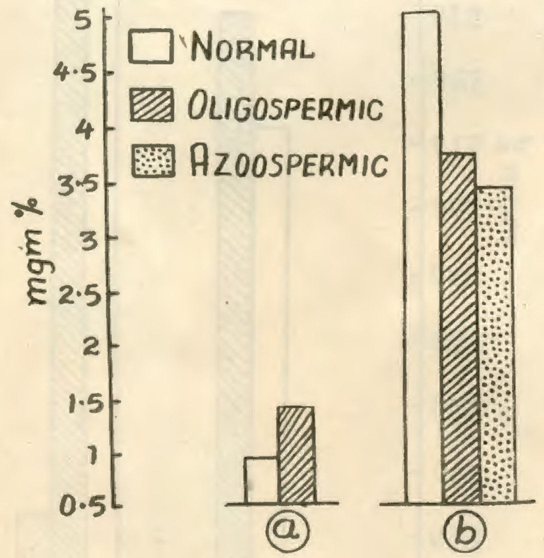

Fig. 4
Magnesium ion concentrations in (a) semen, and (b) seminal plasma.

of electrolyte variation minimum 10 days abstinence was observed by subjects before collecting samples.

Sperm motility being either excellent or fair in our study, correlation with electrolyte concentration was found difficult.

Table II shows results of our study of normal semen and seminal plasma along with that of other workers. It is important to project that we did study maximum number of samples.

Sodium was more (< 0.01) in seminal plasma than in whole semen (Table 1, Graph 1). This was contradicting the results of Quinn *et al* (1965) (Table II). Our values for sodium were higher. But the range was limited.

Probable contributing reasons for this kind of electrolytic variations in the results by different authors may be because of the different methods used by them. Also it is interesting to note at this juncture the study of Singh *et al* (1968) in spermatozoa and seminal plasma of buffalo. They observed seasonal variation in sodium content; higher content in cold

TABLE II

Results of Electrolytic Study in Semen and Seminal Plasma Reported by Different Authors

Authors	Number of Samples	Sample	Sodium	Potassium	Calcium	Magnesium
Bondani et al	53	S	296 247—378	80 47—159	32.4 11—69	11.4 5—22
Gaffarin et al.	21	S	265 230—306	91 66—106	33.6 13.9—61.6	13.5 11.2—16.1
Huggins et al.	34	S	269 230—306	89 66—105	24.8 21.2—30	—
Lundquist					30 14—62	
Quinn et al.	10 10	S SP	308 ± 9.2 258 ± 9.2	8.8 ± 5.2 9.1 ± 10.9	20.6 ± 1.65 28.2 ± 3.3	6.5 ± 1.32 9.0 ± 1.2
Rule et al.	13	S	258 115—404	96 40—155	18.1 10.5—26.5	9.2 2.5—13
Sheth and Rao (1962)	5	SP	—	126	—	—
Sheth and Rao (1968)	5 5	S SP		128—196 132—202		
White and Macleod		S	269 230—306	89 66—105	36 14—60	14.4
Present study	59 59	S SP	312.26 ± 2.78 (305.2 — 322) 352.9 ± 7.11 (340.4—384.1) (<0.01)	58.62 ± 2.48 (49.92—67.86) 56.05 ± 3.13 (50.7—66.3)	31.77 ± 4.09 (14.2—55.1) 40.3 ± 4.47 (30.6—50)	0.952 ± 0.2 (0.27—1.51) 5.17 ± 0.97 (3.41—6.82) (<0.01)

S = Semen SP = Seminal Plasma

and slightly lower values in hot and hot—humid climates. Lastly, this may be due to climatic, as exampled here, regional or some such other yet unidentified factors.

Our study (Table 1, Graph 2) revealed that potassium was more in whole semen than in seminal plasma, showing more of it in spermatozoa. This observation was again not matching with that at Quinn *et al* (1965) (Table II). They found more potassium in seminal plasma than semen. Sheth and Rao (1968) found no difference.

We conclude that as in other parts of the body compartments in semen also sodium is more present extracellularly and potassium intracellularly. This has been reported in bovine semen (Cragle *et al*, 1958; Salisburry and Cragle, 1956).

Referring to Table II, the minimum level of calcium in semen is reported by Rule *et al* (1970) and the maximum by White and Macleod (1963). We observed (Graph 3) more calcium in seminal plasma supporting the view of Quinn *et al* (1965).

The lowest value for magnesium is observed by us (Table II). It was present more in seminal plasma (Graph 4) than in semen; this was statistically significant (< 0.01). Quinn *et al* (1965) results were the same. The probability of operation of a magnesium pump in sperm may not be ruled out at this level.

One of the causes of male sterility is decreased motility of spermatozoa. A change in the electrolyte concentration may be a contributing factor. Sheth and Rao (1962) observed increased potassium in seminal plasma where motility was less. The motility could also be inhibited by increased concentration of either iron (Loewit, 1971) or calcium or zinc (Rosado, 1970) in seminal plasma.

Only few reports (Bondani *et al*, 1973; Gaffarin *et al*, 1969; Rule *et al*, 1970) were available about electrolytic study in oligospermic and/or azoospermic semen.

Referring to Table I and Graph 1, we find slightly elevated sodium in oligospermic semen (a). This can be due to the low density of spermatozoa. In seminal plasma (b) reduction from normal to oligospermic to azoospermic is seen. Reports of Bondani *et al* (1973) (Tables III & IV) show 6 mgm% more in oligospermia and 11 mgm% less in azoospermia. Normally sodium is present more in testicular plasma and is resorbed by epididymal cells to a certain extent (Mann, 1975) and later on during its journey accessory glands contribute it. Prostate gland empties 3.6 gm per litre (Huggins *et al*, 1941). The decrease in sodium level both in oligospermic and azoospermic may be due to either less production of sodium at testicular and/or glandular levels or increased resorbtion in epididymis. It may not be difficult to find out that less sodium is a cause of less spermatozoa or vice versa.

Referring to Table I and Graph 2, 7 mgm% of more potassium is observed in oligospermic semen (a). While reading graph (b) it is easy to note that this increased potassium is due to more of it in seminal plasma. A reverse pattern to sodium levels is seen in case of potassium. Study of Bondani *et al* (1973) did not find much difference among all the 3 groups (Tables III & IV). A distinctly higher potassium to sodium ratio is existing at the point of sperm entry into the epididymis. However, in cauda epididymis this ratio is lowered (Mann, 1975). From our study we conclude that secretion is increased, and/or resorption of it is decreased.

TABLE III

Results of Normal and Oligospermic in mgm% Compared With the Results of Bondani et al

	Bondani et al.				Present study			
	Sodium	Potassium	Calcium	Magnesium	Sodium	Potassium	Calcium	Magnesium
Normal (SP)	296	80	33	11.4	353	56	40	5.17
Oligospermic (SP)	302	83	36	13	340.3	64	32	3.66
Normal (S)					312	58.6	32	1
Oligospermic (S)					330 <0.01	59	41	1.38

SP = Seminal Plasma S = Semen

TABLE IV

Results of Normal and Azoospermic in mgm% Compared With the Results of Bondani et al

	Bondani et al.				Present study			
	Sodium	Potassium	Calcium	Magnesium	Sodium	Potassium	Calcium	Magnesium
Normal (SP)	296	80	32	11.4	353	56	40	5.17
Azoospermic (SP)	285	89	32	11.0	252	76	44	3.4
					<0.01	<0.01		

SP = Seminal Plasma

We observed a high sodium to potassium ratio in seminal plasma, reverse pattern to epididymal fluid. That the ratio decreased from normal to oligospermia to azoospermia as shown below is an important observation.

normal	..	6.3
oligospermia	..	5.5
azoospermia	..	3.3

Calcium was 9 mgm% more in semen with oligospermia than normal (Table I, Graph 3a). It being an extracellular component, more was observed in seminal plasma of normal and in azoospermia it still increased. However, in oligospermia the level was 10 mgm% less than normal. Bondani *et al* (1973) (Table III & IV) did not observe any change in seminal plasma of normal and azoospermia; but a slight increase was observed in oligospermia. Concentration of calcium in rete testis fluid is about half that in blood plasma. Since prostatic secretion serves as a main source for calcium it will be present in semen even in obstructive type of azoospermia.

Our value for magnesium is the lowest when compared to that of others (Table 2). We observed more of it in seminal plasma than semen as reported by Quinn *et al* (1965).

In normal semen (Fig. 4a) magnesium was less than oligospermic semen, whereas Bondani *et al* (1973) observed reverse to it (Table IV). In case of seminal plasma (Fig. 4b) it was more in normal, less in oligospermic and still less in azoospermic. Bondani *et al* (1973) (Tables III & IV) show slight elevation in magnesium content in oligospermia and no difference in azoospermia. Magnesium is almost half in rete testis fluid than blood plasma (Mann 1975). It seems magnesium release into the rete testis depends on spermatogenesis but a minimum may be released as seen in azoospermic group, to which it is added from other sources.

Summary

Normal, oligospermic and azoospermic seminal plasma and/or semen were studied for concentration of sodium, potassium, calcium and magnesium. In normal semen sodium is found more extracellularly and potassium more intracellularly. A highly distinct sodium to potassium ratio is present in seminal plasma. This declined from normal to oligospermia to azoospermia. A significant increase of sodium (< 0.01) and magnesium (< 0.01) in seminal plasma than semen was observed. Statistically significant (< 0.01) was decline of sodium in semen from normal to oligospermia to azoospermia. Also in case of potassium significant elevation was noticed in azoospermia (< 0.01). Probable reasons are discussed.

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