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Comparative Postmortem Chemistries of Vitreous Humor Before and After Embalming

While over thirty papers [*1*] discuss the use of vitreous humor to determine biochemical or toxicological abnormalities that may have existed prior to death, only three of these mention the use of vitreous humor from embalmed bodies. Sturner and Gantner [2], reporting on postmortem glucose determinations of vitreous humor, stated that of eight embalmed cases the results of all but one were in the proposed normal range. The single exception was a 12-year-old girl who died of botulism and whose vitreous sugar 24 h after embalming was 108 mg/dl. They further mentioned that in one case, eight days elapsed without appreciably altering a supposedly normal value. Scott et al [*3*] reported on the use of vitreous humor for determination of ethyl alcohol in embalmed bodies. They found good correlation between preembalming and postembalming alcohol levels, with a mild decrease in postembalming specimens noted. Finally, there is one case report by Coe [*4*] in which there was determination of barbiturates in the vitreous humor of a body embalmed 32 days before. His report is included as part of an article on general problems in postmortem chemistry.

Medical examiners may be forced to perform examinations on embalmed bodies for several reasons. This paper is concerned with what information can be obtained from examining the vitreous humor on such embalmed bodies in relation to the tests commonly performed on vitreous humor from unembalmed individuals: electrolytes, urea, and glucose. It was also decided to repeat the work of Scott et al [*3*] on vitreous alcohol during the study.

Procedures and Results

When a body was brought to the morgue, all the fluid available was aspirated from the right eye using a 5-cm^3 syringe and #20 needle. This fluid was immediately sent to the clinical laboratory where values for sodium, potassium, chloride, glucose, and urea nitrogen were obtained. This was done by using a Technicon SMA 6/60 AutoAnalyzer (Technicon Instrument Corp., Ardsley, N. Y.) in which the procedures for sodium, potassium, chlorides, and urea nitrogen were those developed for the machine by the manufacturer while the glucose was measured by a glucose oxidase-peroxidase procedure. Besides the tests for common biological substances, the vitreous humor was also examined for ethanol in all cases where blood specimens from the body showed the

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presence of alcohol. These tests were performed by gas chromatography using a Shimadzu-4BPF instrument with dual column, dual flame ionization detector.

After the body was taken by the mortician, the time of embalming was determined and the vitreous humor from the left eye was aspirated as long after the embalming as was feasible. A sample of embalming fluid was obtained at the same time and was analyzed on the Technicon 6/60 simultaneously with the embalmed vitreous fluid. The sample was also tested for ethanol in cases where alcohol was found to be present in the preembalming specimen.

Preembalming and postembalming specimens from 35 individuals were analyzed. The results are given in Table 1. Analysis of the samples of embalming fluid showed varying amounts of sodium, potassium, and chloride but no urea, glucose, or ethanol. In general, the embalming fluids appeared to be approximately isotonic.

Discussion

Examination of vitreous sodium and chloride values after embalming show uniformly lower values than the preembalming specimens with the single exception of Case 898. The degree of fall was erratic and apparently not related to the times of embalming or of obtaining the second specimen. Thus it is impossible to use abnormal postembalming sodium and chloride values as evidence of electrolyte imbalance, as can be done with unadulterated vitreous humor [*5*].

In contrast, urea nitrogen and glucose determinations from embalmed vitreous specimens may provide useful information. Urea nitrogen is recognized as being one of the most stable substances in the vitreous humor [*5*] so that the almost uniform fall in the amount of urea after embalming undoubtedly represents a dilutional effect produced by the embalming fluid. Despite this dilution, in the four cases with only a mild elevation of urea in the preembalmed vitreous humor (Cases 834, 933, 1000, and 1673) all but one continued to show significant elevation in the postembalming specimen. In the single case (1090) having a markedly elevated urea nitrogen in the preembalming specimen, the postembalming specimen also showed a very high value. It is felt that a diagnosis of uremia can safely be made from examination of the vitreous humor after embalming.

Examination of glucose values obtained from vitreous specimens before and after embalming reveal, almost uniformly, a fall consistent with the previously established fact of vitreous glycolysis [*5*] in the normal eye after death. There were five cases showing mild elevations of glucose in the preembalming specimen (Cases 895, 898, 920, 1000, and 1673). Of these five, two of the individuals were not diabetic (Cases 920, and 1000). In these two cases the fall in glucose between the first and second specimens was very pronounced, giving postembalming values of less than 20 mg/dl. In contrast, the three elevated values from diabetics (Cases 895, 898, and 1673) revealed that the glucose concentration remained significantly elevated after embalming, and one sample actually showed an increase in the amount of glucose. The fact that glycolysis occurs much more slowly in the diabetic and that elevated glucose values in the vitreous humor of diabetics may actually appear to rise with increasing postmortem time has already been demonstrated [*5,6*]. The figures in this study, although limited in number, would indicate that a diabetic out of control and in acidosis with a high vitreous glucose level would continue to show this chemical abnormality after the embalming process. No acetone was found in any of the samples obtained from the diabetics in this study so that the effects of embalming on the acetone determination could not be determined.

In the ten samples in which alcohol was found the present work supports the findings of Scott et al [*3*]. Again, there was a dilutional factor in the postembalming vitreous samples which were lower than those from the preemblaming specimens. The decrease

Case	Preembalming						Time [b]		Postembalming					
	Sodium	Potassium	Chlorides	Urea	Glucose	Alcohol	Embalming, h	Second Specimen, h	Sodium	Potassium	Chlorides	Urea	Glucose	Alcohol
832	143	5.4	121	10	61	...	24	24	126	13	107	9	16	...
834	134	4.2	105	54	80	...	6	24	112	15	83	33	56	...
835	146	5.4	121	13	47	...	12	48	106	22	78	9	33	...
866	144	5.3	124	15	46	...	3	20	127	14	110	6	18	...
885	140	4.6	105	17	58	...	190	72	102	26	60	...	8	...
893	151	9.0	124	19	15	...	30	72	125	25	92	9	23	...
895	140	10.8	115	31	152	...	4	18	118	17	92	25	135	...
896	150	12.0	133	13	13	...	50	24	127	25	104	11	6	...
898	141	4.3	118	24	100	...	20	40	156	16	87	0	92	...
899	154	8.5	121	18	13	0.05	4	48	122	22	90	15	0	0.02
900	156	6.8	125	16	39	...	24	24	137	19	111	13	0	...
918	139	4.7	111	17	77	...	6	20	111	10	94	6	25	...
920	154	5.7	127	10	113	...	40	...	96	26	71	1	9	...
925	151	5.9	126	14	55	...	6	...	123	20	107	7	10	...
933	144	5.2	123	32	35	...	4	90	105	23	84	14	35	...
939	144	10.0	121	7	21	...	20	72	106	26	82	...	16	...
950	143	6.4	123	8	17	0.14	40	24	126	22	107	6	0	0.11
960	142	6.8	123	8	45	...	24	20	113	18	93	2	10	...
961	135	6.7	112	7	0	...	...	24	107	17	79	4	6	...
965	138	18.5	121	...	6	0.26	20	24	100	20	85	...	6	0.21
966	143	5.5	124	13	57	...	20	20	118	15	109	9	11	...
972	147	4.8	125	16	53	...	12	3	135	10	113	9	20	...
979	145	12.0	127	9	9	...	5	24	123	20	107	7	9	...
996	144	5.4	126	8	70	0.21	15	72	118	22	99	5	20	0.19
1000	133	4.4	112	33	121	...	24	48	122	22	95	33	11	...
1003	148	6.6	122	24	52	...	4	48	116	17	89	11	27	...
1013	142	6.8	122	22	35	...	24	20	131	19	113	17	8	...
1019	154	5.9	127	9	70	0.17	6	20	136	13	110	8	65	0.06
1024	143	5.4	124	18	60	0.15	18	20	130	16	114	12	15	0.15
1025	150	7.8	126	7	46	0.24	10	22	140	15	121	7	8	0.21
1029	144	5.7	123	21	36	...	3	22	128	12	110	12	21	...
1049	148	6.0	124	16	28	0.07	15	6	127	17	103	15	8	0.05
1089	145	9.1	125	10	23	0.24	3	18	95	15	81	7	5	0.14
1090	147	10.8	119	186	25	0.16	3	18	119	18	97	144	22	0.14
1673	153	4.2	118	30	274	...	12	48	138	17	107	32	289	...

[a] Sodium, potassium, and chlorides, mEq/litre; urea and glucose, mg/dl; alcohol, % w/v.

[b] Embalming = time between drawing vitreous from right eye and embalming; second specimen = time between embalming and drawing vitreous from left eye.

in concentration was usually insignificant, but in two of the ten cases (Cases 1019 and 1089) the fall between the first and second specimens was 0.10% w/v.

This study encompasses only the relatively early postembalming period, with the longest time between embalming and obtaining of the vitreous specimen being less than four days. Thus the conclusions drawn must apply only for examination of the recently embalmed individual and may not hold for examination of vitreous from disinterred bodies weeks, months, or years after the embalming.

Summary

Examination for common biochemical substances in the vitreous humor of embalmed bodies indicates that individuals with significant nitrogen retention or diabetics with marked elevation in vitreous glucose will be recognized by standard laboratory procedures on postembalming specimens.

The work of Scott el al [*3*] on vitreous alcohol in the embalmed body has been substantiated with good general agreement found between specimens obtained before and after the embalming process.

Addendum

A referral submitted after press deadline concerned a 17-year-old, black, insulin-dependent diabetic woman who deteriorated rapidly after she discontinued medication. Autopsy showed no cause of death, but urine gave a 3+ reaction for glucose and a strongly positive test for acetone. No other chemical tests were done at that time. Vitreous humor obtained after exhumation (eleven days after death) had a glucose of 772 mg/dl and an acetone of 17 mg/dl. The embalming fluid had a significant amount of isopropynol but no glucose or acetone. The glucose level supports the conclusion that diabetes out of control can be diagnosed after embalming, but interpretation of the ketosis is hampered because some of isopropynol of the embalming fluid could, theoretically, break down to form acetone.

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