Brief Report

The Electrophoretic Mobility of Erythrocytes of Patients with Malignant Tumors

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With the technical assistance of Kathryn Amendola

The electrophoretic mobilities of washed erythrocytes of patients with carcinoma and lymphoma are reported to be less than those of red cells of normal persons or patients with benign tumors. This paper reports the results of a similar study in which we were unable to demonstrate such differences.

Materials and Methods

Blood samples were collected in ethylene diaminetetraacetate and refrigerated at 4°C. Mobilities were determined within 24 hours of collection. Immediately prior to mobility determination, 1 volume of blood was washed three times with 10 volumes of 1 per cent NaCl, and a 0.2 per cent suspension of red cells was prepared in Michaelis acetate-barbital buffer (pH 9, ionic strength 0.172).

Apparatus

The microelectrophoresis apparatus consists of a laterally oriented rectangular chamber and Ag-AgCl electrodes. This has been described in detail previously. Since that description several minor technical changes have been made in order to facilitate cleaning and repair of the apparatus. The sintered glass discs which separate the observation chamber from the electrode compartments are vertically oriented and are fused to the ends of male halves of 10/30 Pyrex® joints which join the electrode compartments. The female halves of these joints are sealed to the side arms of the observation chamber. The joints are sealed with Apiezon® grease and held together with steel springs. The pore size of the sintered discs is 0.9–1.4 μ (instead of 4–5.5 μ). The silver-silver-chloride electrodes are stored in situ in the electrode compartments which contain saturated KCl and a small amount of crystalline KCl. The KCl is changed every 1–2 weeks as part of the general cleaning of the apparatus.

Calculations

The electrophoretic mobility was computed from the equation \( U = \frac{dAK}{I} \) where \( U \) is the electrophoretic mobility, \( d \) is the distance traveled by the red cell in time \( t \), \( A \) is the cross-sectional area of the chambers, \( K \) is the specific conductance and \( I \) is the current.

Reproducibility

Multiple mobility determinations on a single red cell sample usually were reproducible ±5 per cent.
Table 1.—Red Cell Mobilities of Patients with Carcinoma, Lymphoma and Benign Surgical Disorders

<table>
<thead>
<tr>
<th>Disorder</th>
<th>Number</th>
<th>Mean Mobility*</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carcinoma</td>
<td>32</td>
<td>-1.11 ± 0.08</td>
<td></td>
</tr>
<tr>
<td>Lymphoma</td>
<td>23</td>
<td>-1.13 ± 0.06</td>
<td></td>
</tr>
<tr>
<td>Benign surgical disorders</td>
<td>123</td>
<td>-1.13 ± 0.07</td>
<td></td>
</tr>
<tr>
<td>Tumorous</td>
<td>43</td>
<td>-1.13 ± 0.06</td>
<td></td>
</tr>
<tr>
<td>Nontumorous</td>
<td>80</td>
<td>-1.13 ± 0.08</td>
<td></td>
</tr>
</tbody>
</table>

*μ/sec/volt/cm. in Michaelis Buffer, pH 9, ionic strength 0.172 at 25 ± 0.1 C.

Procedure

Mobility and resistance determinations were performed in a constant temperature water bath at 25 ± 0.1 C. Mobilities were calculated from an average of 20 red cell migrations for each specimen. Each day specimens from patients with benign and malignant disorders were included. The diagnoses were not known by the person determining the mobilities.

Subjects

Preoperative blood samples were collected from 32 patients with carcinoma and 123 patients undergoing elective surgery for nonmalignant disorders. No patients in the latter group had febrile or systemic illnesses. Twenty-three patients with lymphoma were also studied. All diagnoses of malignant and benign tumors were established histologically, as were diagnoses of nontumorous conditions where appropriate.

The types of carcinoma and numbers of patients were as follows: breast, 6; bladder, 4; colon, 4; basal cell, 3; cervix, 3; ovary, 3; prostate, 2; lung, 1; lympho-epithelioma, 1; melanoma, 1; penis, 1; stomach, 1; thymus, 1; tongue, 1.

The types of lymphoma and number of patients were as follows: lymphosarcoma, 11; Hodgkin's disease, 10; reticulum sarcoma, 2.

The 123 patients without malignancies consisted of 43 with benign tumors and 80 with nontumorous conditions. The types of benign tumors and numbers of patients were as follows: fibrocystic disease of breast, 9; leiomyoma, 5; fibroadenoma of breast, 4; polyp of colon, 4; prostatic hypertrophy, 4; ganglion, 3; intraductal papilloma of breast, 3; thyroid adenoma, 3; Brenner tumor of ovary, 1; cervical polyp, 1; cystadenoma of ovary, 1; endometriosis, 1; meningioma, 1; osteochondroma, 1; pilonidal cyst, 1; synovial cyst, 1.

The types of nontumorous conditions and numbers of patients were as follows: cholelithiasis, 13; hernia, 10; ophthalmologic disorders, 10; lower urinary tract infection (cystoscopy), 7; normal tissue biopsy, 7; orthopedic disorders, 7; orthotilarthropologic disorders, 6; plastic procedures, 5; functional uterine bleeding, 4; hemorrhoids, 3; varicose veins, 2; abscess, 1; diverticulosis, 1; duodenal ulcer, 1; gastric ulcer, 1; peripheral vascular disease, 1; salivary duct stone, 1.

Results

It can be seen from the results presented in table 1 that there were no appreciable differences among the red cell mobilities of patients with carcinoma, lymphoma, and tumorous or nontumorous benign surgical conditions.

Discussion

We were not able to confirm the finding of Rottino and his co-workers that the electrophoretic mobility of red cells is lower in malignant disease than in subjects without malignancies. The mean mobilities of red cells reported
by Rottino and Angers\textsuperscript{1} for normal subjects were $-1.33 \pm 0.05 \mu\text{sec/volt/cm.}$, for patients with carcinoma $-1.16 \pm 0.02$, and with lymphoma $-1.09 \pm 0.05$. We obtained mean mobilities in benign and nonmalignant conditions of $-1.13 \pm 0.07$, in carcinoma $-1.11 \pm 0.08$, and in lymphoma $-1.13 \pm 0.06$, using the same acetate-barbital buffer as the latter authors.

It is difficult to account for the differences in the data reported by Rottino and his co-workers\textsuperscript{1,3} and those contained in the present report. Not only did we fail to find that red cells of patients with malignant tumors migrated more slowly than those of subjects without malignant disorders but the mobility values for subjects without tumors differed significantly between the two groups of workers. This is so despite our use of the same buffer and technic of sample preparation as used by Rottino et al.\textsuperscript{6} It might be pointed out that our mobilities are very similar to those of Ponder and Ponder\textsuperscript{7} who obtained mobilities of $-1.0 - 1.1 \mu\text{sec/volt/cm.}$ using the same acetate-barbital buffer.\textsuperscript{8} We can only suggest that differences in other aspects of the technic such as timing method, field strength, or microelectrophoresis apparatus may account for the contrasting results obtained.

**Summary and Conclusions**

The electrophoretic mobilities of erythrocytes of 123 patients with benign surgical conditions and 55 patients with malignant disorders were determined. There was no appreciable difference between the mobilities of the two groups. In our hands microelectrophoresis of washed, untreated erythrocytes is not a useful tool in the diagnosis of human malignancies.

**Summario in Interlingua**

Esseva determinate le mobilitates electrophoretic de erythrocytos ab 123 patientes con benigne conditiones chirurgic e ab 55 patientes con disordines maligne. Esseva constatate nulle appreciabile differentia inter le mobilitates in le duo gruppos. In nostre manos, microelectrophorese de lavate, non-pretractate erythrocytos non es un utile instrumento in le diagnose de malignitates human.

**References**


\*It should be noted that the red cell mobilities reported in the present paper are not comparable to those previously reported from this laboratory.\textsuperscript{9} The phosphate buffer used in the previous study gives mobilities about 25 per cent faster than those obtained with the acetate-barbital buffer used in the present study.

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