Heterologous Growth and Passages of Mouse Sarcomas in Hamsters (Mesocricetus auratus)*

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It has been apparent since early in the history of cancer research that the study and experimental therapy of human cancer might be considerably advanced if the neoplasms could be grown outside of the body of the cancer patient. Besides tissue culture in vitro, there is the possibility of growth of tumor transplants in host animals. Experimentally, this problem resolves itself into that of the successful heterologous growth of tumors of any species. Early efforts in this field have been reviewed in a previous paper (9), which dealt with the successful heterologous growth of mouse Sarcoma 180 in suckling rats, but not in adult rats. The present communication concerns the use of hamsters as host animals for mouse sarcomas.

The hamster is a comparative newcomer to cancer research, and there are not many reports of its use. There is a single report of spontaneous transmissible tumors in hamsters. Ashbell (1) found thirteen tumors in a total of 1,000 animals. Two polymorphous-cell sarcomas, one carcinoma, and two of ten cortical hypernephromas were transplantable to other hamsters.

The earliest experimental work reported is that of Gye and Foulds (5). A mixed-cell sarcoma transplantable to other hamsters was induced in a male injected with 3,4-benzpyrene.

Halberstaedter (6) induced a similar sarcoma with benzpyrene in a hamster. The original host had no metastases, but in the passages the tumor was occasionally found to involve lymph nodes, kidneys, and lungs.

Crabb (3) induced transplantable sarcomas in hamsters with 9,10-dimethyl-1,2-benzanthracene. Metastases occurred in lymph nodes, kidneys, and lungs in the course of seventeen passages. Attempted transplantations of the hamster sarcoma to mice failed.

Nettleship and Smith (8) transplanted a hamster fibrosarcoma induced with 20-methylcholanthrene for five generations without noting any metastases.

Lutz, Fulton, Patt, and Handler (7) used the cheek pouch of the hamster as a site for the transplantation of hamster tumors.

Greene (4) transplanted the Brown-Pearce tumor of the rabbit into testicles, anterior chamber of the eye, and subcutaneous tissue of hamsters. The tumor growth that occurred was followed by regression.

MATERIALS AND METHODS

A study was made of the ability of Crocker mouse Sarcoma 180 and a transplantable methylcholanthrene-induced spindle-cell mouse sarcoma to grow in young and adult hamsters. The latter tumor originated in 1948 in a C57 black mouse and proved to be transplantable to various strains of mice. A Swiss mouse bearing the 74th passage of this tumor was used as donor for the hamster experiments.

Cell suspensions were made by mincing a 7-day-old tumor with fine scissors and adding equal parts of Locke-Ringer solution at pH 7.0. The suspension was then injected intraperitoneally or subcutaneously in the volumes given in Tables 1 and 2. The recipient hosts for mouse Sarcoma 180 were hamsters of various ages, but only adult hamsters were hosts for the methylcholanthrene-induced mouse sarcoma. The hamsters were from various sources over several years, but all were Syrian hamsters, Mesocricetus auratus.

The viability of each mouse tumor used in these hamster experiments was checked by simultaneous implantation into Swiss mice of Carworth or Rockland Farms stock. This was true not only of the mouse tumors taken from mouse hosts but also of the mouse tumors taken from hamster hosts.

RESULTS

Results of the injection of Sarcoma 180 cell suspension into hamsters are given in Table 1. Minced Sarcoma 180 proliferated readily on injection into hamsters 1–6 days old. Hamsters injected intraperitoneally when less than 1 day old died from the
tumor growth within 5–12 days, the average being 9 days. Successful transplantations of the mouse tumor appeared to decrease in relative frequency with the age of the hamster hosts, although serial passages could be made in adult hamsters. Subcutaneous injections of Sarcoma 180 cells into a few hamsters 1 and 2 days old were followed by successful growth for 19–15 days before regression occurred. There were no regressions except in the four animals of experiment 177. All checks on viability of Sarcoma 180 donor tumors by injection into mice resulted in successful tumor growth in the inoculated mice.

At autopsy of host hamsters that had received intraperitoneal injections, tumors were found in the peritoneal cavity as follows: under the liver lobes, attached midway on the spleen, on the small intestine, and along the lower gastrointestinal tract. There were also a few metastases to the lung; similar lung metastases had been obtained with Sarcoma 180 in young rats (9). Figure 1 illustrates intraperitoneal tumors of mouse Sarcoma 160.

### Table 1

<table>
<thead>
<tr>
<th>Exp. No.</th>
<th>Age (mo.)</th>
<th>No.</th>
<th>Injection Route</th>
<th>cc.</th>
<th>Takes</th>
<th>Day Hamster Died (D) or Was Killed (K)</th>
</tr>
</thead>
<tbody>
<tr>
<td>126</td>
<td>1 day</td>
<td>2</td>
<td>Sube.</td>
<td>0.05</td>
<td>2/2</td>
<td>K7, 7</td>
</tr>
<tr>
<td>177</td>
<td>4 days</td>
<td>4</td>
<td>Sube.</td>
<td>0.1</td>
<td>4/4</td>
<td>K16, 18, 18, 18</td>
</tr>
<tr>
<td>105</td>
<td>1 day</td>
<td>7</td>
<td>I.P.</td>
<td>0.05</td>
<td>7/7</td>
<td>K10, 10, 10</td>
</tr>
<tr>
<td>128</td>
<td>1 day</td>
<td>5</td>
<td>I.P.</td>
<td>0.05</td>
<td>5/5</td>
<td>D5, 6, 6, K4, 6</td>
</tr>
<tr>
<td>155</td>
<td>1 day</td>
<td>5</td>
<td>I.P.</td>
<td>0.05</td>
<td>5/5</td>
<td>D8, 6, 9, 9, 10</td>
</tr>
<tr>
<td>171</td>
<td>1 day</td>
<td>4</td>
<td>I.P.</td>
<td>0.05</td>
<td>4/4</td>
<td>K11, 11, 11, 11</td>
</tr>
<tr>
<td>172</td>
<td>6 days</td>
<td>5</td>
<td>I.P.</td>
<td>0.05</td>
<td>4/5</td>
<td>K11, 11, 11, 11</td>
</tr>
<tr>
<td>173</td>
<td>19 days</td>
<td>3</td>
<td>I.P.</td>
<td>0.05</td>
<td>1/3</td>
<td>K15</td>
</tr>
<tr>
<td>174</td>
<td>45 days</td>
<td>5</td>
<td>I.P.</td>
<td>0.05</td>
<td>0/5</td>
<td></td>
</tr>
<tr>
<td>185</td>
<td>3–6 mo.</td>
<td>15</td>
<td>I.P.</td>
<td>0.05</td>
<td>2/15</td>
<td>K11, 11</td>
</tr>
<tr>
<td>163</td>
<td>5–6 mo.</td>
<td>14</td>
<td>I.P.</td>
<td>0.05</td>
<td>5/14</td>
<td>K11, 11, 11, 34; D51</td>
</tr>
<tr>
<td>168</td>
<td>5–6 mo.</td>
<td>15</td>
<td>I.P.</td>
<td>0.05</td>
<td>1/15</td>
<td>K21†</td>
</tr>
<tr>
<td>169</td>
<td>4–7 mo.</td>
<td>5</td>
<td>I.P.</td>
<td>0.05</td>
<td>1/5</td>
<td>K17†</td>
</tr>
<tr>
<td>175</td>
<td>4–7 mo.</td>
<td>3</td>
<td>I.P.</td>
<td>0.1</td>
<td>1/3</td>
<td>K25†</td>
</tr>
<tr>
<td>4–7 mo.</td>
<td>2 Sube.</td>
<td>0.1</td>
<td>0/2</td>
<td>K25</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Accompanying the passages into hamsters, control transplantations into mice always grew. I.P. denotes intraperitoneal, Sub. denotes subcutaneous inoculation.
* Only the sarcomas in the four hamsters of experiment 177 regressed, after an initial period of growth.
* Donor for next passage.

### Table 2

<table>
<thead>
<tr>
<th>Exp. No.</th>
<th>Age (mo.)</th>
<th>No.</th>
<th>Injection Route</th>
<th>cc.</th>
<th>Takes</th>
<th>Day Hamster Killed (K) or Found Dead (D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>164</td>
<td>3–6 mo.</td>
<td>13</td>
<td>I.P.</td>
<td>0.1</td>
<td>4/15</td>
<td>K11, 11, 21, 21†</td>
</tr>
<tr>
<td>165</td>
<td>3–6 mo.</td>
<td>12</td>
<td>I.P.</td>
<td>0.1</td>
<td>1/12</td>
<td>K21†</td>
</tr>
<tr>
<td>170</td>
<td>4–7 mo.</td>
<td>5</td>
<td>I.P.</td>
<td>0.1</td>
<td>4/5</td>
<td>D18; K16, 16, 16†</td>
</tr>
<tr>
<td>176</td>
<td>4–7 mo.</td>
<td>2</td>
<td>Sube.</td>
<td>0.1</td>
<td>0/2</td>
<td>K25, 25†</td>
</tr>
<tr>
<td>4–7 mo.</td>
<td>3</td>
<td>I.P.</td>
<td>0.1</td>
<td>3/3</td>
<td>K25, 25†</td>
<td></td>
</tr>
</tbody>
</table>

* There were no regressions in those hamsters in which tumor growth occurred. In the passages above, control transplantations of the sarcoma into mice always grew. I.P. denotes intraperitoneal, Sub. denotes subcutaneous inoculation.
* Donor for next passage.
180 in an adult hamster, while Figure 2 shows them in two young hamsters. In Figure 2, line b indicates metastatic nodules in the lung. Figure 3 is a photomicrograph of a lung section with Sarcoma 180 metastases from a young hamster 12 days after intraperitoneal injection of Sarcoma 180 mince.

The Sarcoma 180 donor tumor used for the second passage was taken from a hamster 21 days after implantation. On histological examination, the donor tumor showed a little necrosis, but mitoses and viable cells were present. The tumor for the third passage was 17 days old; it had a necrotic center but viable cells peripherally. The tumor for the fourth passage, 25 days old, was largely necrotic but contained some viable areas. It is to be noted that Sarcoma 180 is usually transplanted in this laboratory from mouse to mouse every 7 days, because necrosis in older tumors reduces the frequency of successful transplantation.

Results of the injections of minced methylcholanthrene-induced mouse tumor into adult hamsters are given in Table 2. In the first passage, 5 of 25 hamsters injected intraperitoneally with tumor from a mouse developed tumors. The donor tumor for the second passage was taken after 21 days’ growth in a hamster; intraperitoneal inoculations gave successful tumor growth in four of five hamsters. The donor tumor for the third passage was 16 days old; all of three intraperitoneal injections, were followed by successful growth. The fourth passage donor tumor, 25 days old, was injected into mice only, with complete success. No regressions were noted in any of the hamster hosts of this mouse sarcoma, although they were allowed to live for 11–25 days after inoculation. Figure 4 illustrates the intraperitoneal tumors in an adult hamster injected with this mouse sarcoma. The histological appearance of the methylcholanthrene tumor in its 74th passage in mice, in the hamster, and again in the mouse, after having grown in a hamster, is illustrated in Figures 5, 6, and 7, respectively. The cells appear to have undergone no drastic alteration in morphology, despite the changes of host.

The authors are indebted to Dr. J. D. Allen, of the Pathology Department, Memorial Hospital, for the histological examinations.

DISCUSSION

Sarcoma 180 transplants grew on inoculation into the peritoneal cavity of young rats but not in adults (9), while in hamsters this sarcoma evinced some ability to grow through successive passages in adult animals. The methylcholanthrene-induced spindle-cell sarcoma of the mouse also grew through successive intraperitoneal passages in adult hamsters. It thus appears that the hamster may prove to be a better host animal for heterologous tumors than is the rat, and it is suggested that the possibility of using the hamster as a culture medium for human neoplasms be investigated.

SUMMARY

Serial passages of Crocker mouse sarcoma 180 and a methylcholanthrene-induced mouse sarcoma were made in adult hamsters by means of intraperitoneal inoculation. Sarcoma 180 was transplanted from the mouse to the peritoneal cavity of the hamster with greater success when the hamsters were 1 or a few days old than when older. Subcutaneous inoculations in adult hamsters failed to grow and in suckling hamsters regressed after about 2 weeks of growth. No regressions were noted with either mouse sarcoma implanted intraperitoneally in the hamster.

REFERENCES


Fig. 1.—Adult hamster bearing tumors and dead 31 days after intraperitoneal injection of 0.05 cc. of Sarcoma 180 mince: a and c, tumors on intestine; b, tumor mass under lobe of liver; d, tumor mass attached to spleen. Exp. 163.

Fig. 2.—Two young hamsters (one dead, one killed) bearing tumors 8 days after intraperitoneal injection of 0.05 cc. of Sarcoma 180 mince: a and c, tumor on liver; b, tumor nodules in lung; d, tumor mass in abdominal cavity. Exp. 145.

Fig. 3.—Sarcoma 180 metastases in lung of young hamster that died 12 days after intraperitoneal injection of 0.05 cc. of Sarcoma 180 mince. Exp. 105. Mag. X150.
FIG. 4.—Adult hamster with intraperitoneal tumors, killed 25 days after injection of 0.1 cc. of mince of methylcholanthrene-induced mouse sarcoma: between a and b, a cluster of tumors. Exp. 176.

FIG. 5.—Methylcholanthrene-induced spindle-cell mouse sarcoma, 74th passage in mice. Zenker fixation, hematoxylin and eosin stain. Mag. ×675.

FIG. 6.—Methylcholanthrene-induced mouse sarcoma in hamster. Zenker fixation, hematoxylin and eosin stain. Mag. ×675.

FIG. 7.—Methylcholanthrene-induced mouse sarcoma growing in mouse after passage through hamster. Zenker fixation, hematoxylin and eosin stain. Mag. ×675.
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