Radionuclide Lymphangiography in the Evaluation of Pediatric Patients with Lower-Extremity Edema: Concise Communication

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The results of $^{99m}$Tc-sulfur colloid lymphangiography in seven pediatric patients with lower-extremity edema were reviewed. Three scintigraphic patterns were identified: (A) normal uptake in the ilioinguinal nodes bilaterally, found in edema as a result of extrinsic venous obstruction; (B) diffusely increased activity over the involved extremity, with decreased visualization of the ipsilateral ilioinguinal nodes, found in secondary lymphedema; and (C) markedly decreased uptake by the ilioinguinal nodes on the affected side, found in primary (idiopathic) lymphedema. These preliminary results suggest that radionuclide lymphangiography is a useful procedure in the evaluation of pediatric patients with limb swelling.


The potential use of radiocolloids for the diagnosis of abnormalities of the lymphatic system has been explored over the past 20 years. Techniques employed have included the counting of excised nodal tissue (1-3), in vivo external counting (4), and in vivo lymph-node imaging (5-8). Most of the work in this area has been directed at the application of these techniques to evaluate nodal involvement by neoplastic disease. Radiocolloid lymphatic imaging in the evaluation of pediatric patients with edema of the extremities is essentially unexplored.

Limb swelling in children represents a special diagnostic challenge. In adults, radiographic contrast studies, though invasive in nature, are helpful in investigating the cause of limb swelling of obscure origin, but in children, the risks and technical difficulties of these techniques have limited their usefulness. The clinical experience reported here indicates that radionuclide lymphangiography can provide a safe, simple means of evaluating the status of the lymphatic system in pediatric patients with limb edema.

METHODS AND MATERIALS

The technique for radionuclide lymphangiography involved the subcutaneous injection of $^{99m}$Tc-sulfur colloid (Tc-SC) (15 μCi/lb)* into the medial web spaces of both feet, with subsequent imaging of the pelvis, abdomen, and, when necessary, the lower extremities. Images were obtained in the anterior position with timed exposures of 4 min, collecting in a normal child approximately 50,000 counts from the pelvis. A scintillation camera was used, fitted with a low-energy parallel-hole collimator. Imaging was performed 1-2 hr after injection and in several patients delayed images up to 24 hr after injection were also taken.

In three of the cases, surgery revealed obstruction to either venous (Patient 1) or lymphatic flow (Patients 2 and 3) in the affected extremity. In the other four cases, a diagnosis of primary lymphedema was established by the clinical history, failure of laboratory studies to identify a systemic cause for the edema, normal contrast venograms (Patients 4 and 6), and x-ray lymphangiography consistent with the diagnosis (Patients 5 and 7).

RESULTS

Summarized patient data and results of the radionuclide studies are presented in Table 1. Three imaging patterns were identified, and they correlated well with the three categories of disease studied. A

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patient with edema due to venous obstruction had a normal lymphangiographic pattern; patients with secondary lymphedema had a pattern suggesting lymphatic obstruction, and those with primary lymphedema showed markedly decreased uptake by the ilioinguinal nodes on the affected side. Examples of these patterns are presented in Figs. 1–3.

DISCUSSION

After subcutaneous injection in the feet, Tc-SC normally migrates upward through the lymphatic channels of the lower limbs. The ilioinguinal nodes are the only lymphatic structures normally visualized, and usually show up as a succession of discrete foci with progressively decreasing activity in the higher nodes (Fig. 1). Activity is often seen over the liver due to radiocolloid that has bypassed the nodes and reached the systemic circulation. This pattern, consistently seen in children and adults without lymphatic abnormalities, is different from that seen with other radiocolloids such as colloidal 198Au, with which the para-aortic lymph nodes are also well visualized (9,10). This is due to the smaller particle size of gold colloids, as compared with Tc-SC (8–10), which allows significant migration beyond the iliac nodes. Particle size of radiocolloids influences their lymphatic distribution. This knowledge has been well documented in the literature (11). The suboptimal imaging characteristics of 198Au, and its higher radiation dose due to beta emissions (8), are drawbacks to the use of this agent. For the problem at hand, Tc-SC is a suitable, readily available radiopharmaceutical.

In the four patients with primary lymphedema, the pattern of markedly decreased visualization of the ilioinguinal nodes on the affected side, without diffuse activity throughout the extremity (which is noted in the cases of secondary lymphedema), suggests decreased migration of the tracer from the injection site due to congenital maldevelopment of the lymphatic channels, the presumed cause of the condition (12). Gates (13) noted essentially the same pattern in an infant with congenital lymphedema evaluated with colloidal 198Au lymphangiography.

In the two patients with secondary lymphedema, the scintigraphic pattern of diffuse activity in the involved extremity and decreased visualization of the ipsilateral inguinal and/or iliac nodes was in sharp contrast with that seen in primary lymphedema. This pattern would be expected as a result of stasis of the radiocolloid distal to a site of lymphatic obstruction. Pure venous obstruction, on the other hand, would not be expected to cause an alteration in the normal scintigraphic pattern.

Radionuclide lymphangiography has several advantages over its radiographic counterpart in the evaluation of children with limb edema: (A) the radiocolloid is injected subcutaneously without significant discomfort to the patient; (b) infants can be studied easily without anesthesia; (c) the presence of edema does not add difficulty to the procedure; (d) there are essentially no complications from the study; and (e) the radiation dose (0.5 rads to the legs and 0.4 rads to the lower abdomen) is similar to that from a radiographic lymphangiogram (0.6–0.9 rads). Therefore, radionuclide lymphangiography can be utilized as a screening procedure, even on an outpatient basis.

On the basis of this limited experience, it would be premature to make more than generalizations regarding the role of radionuclide lymphangiography in diagnosing the cause of lower-extremity edema. A normal lymphoscintigraphic study in a child with extremity edema suggests either a venous or a systemic cause. An abnormal study implicates a primary or secondary lymphatic abnormality, and these two possibilities can be effectively differentiated by

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**TABLE 1. SUMMARY OF PATIENT DATA**

<table>
<thead>
<tr>
<th>Category of disease</th>
<th>Patient no.</th>
<th>Age</th>
<th>Sex—Race</th>
<th>Involved Lower extremity</th>
<th>Imaging Pattern no.*</th>
<th>Final diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Venous Obstruction</td>
<td>1</td>
<td>1 yr</td>
<td>WF</td>
<td>LT</td>
<td>1</td>
<td>Ganglionneuroblastoma</td>
</tr>
<tr>
<td>2° Lymphedema</td>
<td>2</td>
<td>13 yr</td>
<td>BM</td>
<td>LT</td>
<td>2</td>
<td>Lymphoid hypertrophy</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>8.5 mo</td>
<td>WM</td>
<td>RT</td>
<td>3</td>
<td>Benign mesenchymoma</td>
</tr>
<tr>
<td>1° Lymphedema</td>
<td>4</td>
<td>13 yr</td>
<td>BF</td>
<td>LT</td>
<td>3</td>
<td>Lymphedema praecox</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>17 yr</td>
<td>BF</td>
<td>LT</td>
<td>3</td>
<td>Lymphedema praecox</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>14 yr</td>
<td>BF</td>
<td>RT</td>
<td>3</td>
<td>Lymphedema praecox</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>17 yr</td>
<td>BF</td>
<td>BILAT</td>
<td>3</td>
<td>Lymphedema praecox</td>
</tr>
</tbody>
</table>

* Lymphoscintigraphic patterns. 1: normal radiocolloid distribution in the ilioinguinal chain of nodes, bilaterally. 2: diffusely increased activity over the involved extremity and decreased visualization of the ipsilateral ilioinguinal nodes. 3: markedly decreased uptake by the ilioinguinal nodes on the affected side and absence of diffuse uptake as seen in pattern no. 2.
the image pattern. Thus, radionuclide lymphangiography seems useful in the initial evaluation of patients with lower-extremity edema. It avoids the hazards and potential complications of conventional radiographic contrast studies, and provides significant guidance to the clinician in the management of these patients.

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FOOTNOTE

* E. R. Squibb & Sons, Princeton, N.J.

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