Fluorescent Patterns of Intracutaneous Wheals in Normal and Edematous Extremities

By Ray W. Gifford, Jr., M.D., John H. Windesheim, M.D., J. Earle Estes, Jr., M.D., and Grace M. Roth, Ph.D.

Intradermal injection of a fluorescent dye (riboflavin) and ultraviolet light were used to demonstrate cutaneous lymphatic capillaries. The extremities of a control group and the nonedematous extremities of patients with arteriosclerosis obliterans were studied together with edematous extremities of patients with lymphedema, acute thrombophlebitis, chronic venous insufficiency and various other conditions.

The lymphatic capillaries showed up more extensively after a higher percentage of injections into edematous extremities of patients with lymphedema than after injections into the other extremities. On the other edematous extremities except in the cases of nephrotic syndrome and on the normal extremities, either no lymph capillaries or only a few were visible after most of the injections.

During the course of a previous investigation it became apparent that after intradermal injections of a fluorescent substance (riboflavin), a network of capillaries could be demonstrated with greater ease and frequency in the skin of extremities affected by lymphedema than in normal ones.

Subsequently, we have extended our studies to include more than 200 patients and normal subjects. This report is a summary of our findings.

Methods and Materials

Intradermal wheals were made by injecting 0.1 cc. of a solution containing 2.5 mg. of the sodium salt of riboflavin (Flavavin*) per cubic centimeter. Tuberculin syringes and well-sharpened 27-gage, one-half inch long hypodermic needles were used. The injections were made with the subjects in the supine position in a darkened room so that the resultant fluorescent wheals and patterns could be observed immediately under a portable ultraviolet lamp.

These studies were confined to the lower extremities in every case except for one woman in whom a lymphedematous upper extremity was injected.

In most cases the intracutaneous injections were made on the medial aspect of the leg about 3 or 4 cm. superior to the internal malleolus. When pigmentation or ulceration precluded use of this site, injections were made more superiorly. When edema was confined to the dorsum of the foot, injections were made in that region also. Usually more than one injection was made in each extremity studied.

When the intradermal wheals are being made, caution must be exercised lest the injection be too deep in which case the typical patterns will not appear. If any of the solution leaks onto the surface of the skin, surface fluorescence will obscure the underlying pattern.

Selection of Normal Subjects and Patients

For control, injections were made into the skin of the lower extremities of 71 persons who had no history or objective evidence of peripheral edema or any circulatory disorder affecting the lower extremities. Many of these persons were physicians, nurses, secretaries and laboratory technicians. Others were patients, most of whom were hospitalized for treatment of essential hypertension and none of whom had any evidence of disease in the lower extremities. All consented to the procedure.

An attempt was made to study as many patients with edema of the lower extremities as possible provided that the cause of the edema was not complex and was well established. Many of the patients did not have edema at the time of the injections. The condition of the patients and the number in each group will be considered when the observations are reported.

Appearance and Classification of Fluorescent Patterns

A brilliant yellow fluorescent wheal immediately appears when the solution of ribo-
flavin is properly injected into the skin and the region is viewed under ultraviolet light. When the volume of the injection is 0.1 cc., the diameter of the wheal is approximately 1.0 cm. and is remarkably constant except in some edematous extremities where it may be smaller. In addition to the wheal which inevitably appears after all injections, in many extremities, an intertwining reticular pattern may be observed at the periphery of the wheal. This fluorescent reticular network, if present, may form a partial or complete halo around the circumference of the central wheal and may vary from a few millimeters to as much as 10 cm. in width. In general, the larger the reticular pattern, the smaller the central wheal. In some instances, fluorescent reticulation may be seen at some distance from the central wheal and separated completely from it. We have called such discrete and separate areas “islands” after McMaster’s terminology.²

For reasons to be developed subsequently, we have decided that the reticular network represents cutaneous lymphatic capillaries that are filled with the fluorescent solution. If the injections are made under ultraviolet light, the wheal and its surrounding reticular pattern appear simultaneously and promptly. The wheal persists for several hours, but the fine reticulated network surrounding it rapidly loses its identity and soon becomes a diffuse area showing only dim fluorescence. For this reason it is imperative to observe the fluorescent pattern immediately after each injection. Subcutaneous “streamers,” as described by McMaster,² were observed with such irregularity that they were not considered in evaluating the patterns. Furthermore no attempt was made to time the disappearance of the fluorescent areas since this was the subject of a previous investigation.¹

To facilitate the reporting of results the patterns observed were arbitrarily classified into five types as follows:

Type 0 is characterized by a fluorescent wheal with no surrounding reticular network (fig. 1).

Type 1 is characterized by a fluorescent wheal with complete reticular halo not exceeding 1 cm. in its greatest width or an incomplete reticular halo not exceeding 2 cm. in width (fig. 2).

Type 2 is characterized by a fluorescent wheal with complete reticular halo greater than 1 cm. but not exceeding 2 cm. in its greatest width or an incomplete reticular halo from 2 to 4 cm. in greatest width (fig. 3).

Type 3 is characterized by a fluorescent wheal with complete reticular halo greater than 2 cm. but not exceeding 4 cm. in its greatest width or an incomplete reticular halo greater than 4 cm. in greatest width (fig. 4). If
"islands" were present, the pattern was considered to be at least type 3 regardless of whether the other criteria were present.

Type 4 is characterized by a fluorescent wheal with complete reticular halo exceeding 4 cm. in its greatest width with or without "islands."

In this and a previous investigation1 well over 1,500 intracutaneous injections of solutions of riboflavin have been made with no untoward results. Pain resulting from the injections is no greater than that experienced after intracutaneous injection of a similar volume of any nonirritating solution.

**Patterns of "Normal" Subjects**

Of the 71 so-called normal subjects whose legs were injected with riboflavin as a control, 41 were men. The ages of all varied from 19 to 66 years; the mean age was 40 years. The frequency with which the various patterns were observed in normal legs is given in table 1. None of the 268 injections into normal legs resulted in a pattern of type 4 and only four injections resulted in patterns of type 3.

Two women and one man in each of whom one pattern of type 3 was observed were suffering from essential hypertension but none had ever had peripheral edema. The fourth pattern of type 3 was observed in the leg of a female physician, aged 26 years. Each of these four subjects received three additional injections which resulted in patterns of types 0 and 1. "Islands" were observed in three of the four patterns in this group which were classified as type 3.

**Patterns Observed in Patients with Arteriosclerosis Obliterans**

Twelve patients suffering from arteriosclerosis obliterans of the lower extremities were studied. All had ample evidence of severe ischemia but none had ever noted peripheral edema. Ten were men. The ages of all varied from 38 to 83 years and the mean age was 62 years. The frequency with which the various fluorescent patterns were observed in this group is given in table 1. None of the 34 injections resulted in a pattern of type 4 and only one, which was made into an 83-year-old woman, resulted in a pattern of type 3. Three additional injections into the legs of this woman resulted in patterns of types 1 and 2. No "islands" were noted.

A 62 year old man who had arteriosclerosis obliterans was not included in this group of 12 patients because he also had had severe edema of undetermined etiology in both legs for nine months prior to the injection. Numerous injections into this man’s legs resulted repeatedly in patterns of types 2, 3 and 4 without islands.

Because the patterns observed in the ap-

---

**Table 1.—Results in Extremities with No Edema**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Patients</th>
<th>Legs</th>
<th>Injections</th>
<th>Per Cent of Injections</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Type 0</td>
</tr>
<tr>
<td>Normal</td>
<td>71</td>
<td>142</td>
<td>268</td>
<td>48.1</td>
</tr>
<tr>
<td>Arteriosclerosis obliterans</td>
<td>12</td>
<td>24</td>
<td>34</td>
<td>23.5</td>
</tr>
<tr>
<td>Total</td>
<td>83</td>
<td>166</td>
<td>302</td>
<td>45.4</td>
</tr>
</tbody>
</table>

* Instances in which islands occur are also included with results listed as type 3 or 4 in this and the other tables.
parently normal extremities and in extremities with arteriosclerosis obliterans without edema were so nearly identical, the sum of the two were used (table 1) to represent results in extremities free of edema for comparison with results obtained in edematous extremities.

Patterns observed in lymphedema

**Lymphedema praecox.** Twenty-four patients had lymphedema praecox. Twenty were females. The ages of all patients varied from 18 to 81 years and the mean age was 39 years. Lymphedema had been present for three weeks in one patient and for 74 years in another. The average duration of edema was 14 years. Only six of the extremities were not edematous or enlarged at the time of the injections. The frequency with which the various patterns were observed is shown in table 2.

Injections failed to produce at least one pattern of type 3 or 4 in only five legs of four patients. Of these five legs, two were injected only once each and one had been edematous for only five months. The fourth was that of a man, 81 years old, who had had lymphedema of the left leg for 74 years. Despite a Kondoleon operation 30 years previously at which time the leg was estimated to weigh 110 pounds, the limb was massive at the time of the injections. The skin felt and looked like the bark of a tree. Repeated injections into this leg resulted only in patterns of types 0 and 1. The fifth leg which failed to show patterns of types 3 or 4 had been edematous for 23 years and was so cumbersome from chronic enlargement that a modified Homan's operation was undertaken.

Patterns of types 3 and 4 were seen as frequently in extremities with minimal or no edema at the time of injections as in extremities that were grossly edematous. In four extremities injections were repeated after the amount of edema had been reduced by a period of rest in bed with elevation of the legs. In none did the patterns produced by the second injections change appreciably as compared with the first.

In general the duration of edema had no effect on the patterns observed. Patterns of types 3 and 4 were seen as frequently in extremities that had been edematous for less than six months as in those that had been edematous for 10 to 20 years. When edema had been present for more than 20 years, however, patterns of types 3 and 4 tended to be less frequent.

Islands were noted after almost 50 per cent of the injections.

**Obstructive Lymphedema.** Twelve patients with lymphedema secondary to lymphatic obstruction were studied. The obstruction was caused by metastatic carcinoma in 10 patients and by Hodgkin's disease in one, and it followed radical mastectomy in one. Seven of the patients were females. The ages of all varied from 38 to 69 years and the mean age was 53 years. The duration of edema at the time of the injections varied from 1 week to 14 years with a mean of 18 months. Fourteen of the 17 involved extremities had been edematous for less than nine months, however. All but two extremities showed pitting edema at the time of the injections and in eight it was graded 3 or 4 (on a grading basis of 0 to 4). The fre-

### Table 2.—Results in Extremities with Lymphedema

<table>
<thead>
<tr>
<th>Condition</th>
<th>Patients</th>
<th>Legs</th>
<th>Injections</th>
<th>Type 0</th>
<th>Type 1</th>
<th>Type 2</th>
<th>Type 3</th>
<th>Type 4</th>
<th>Islands</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lymphedema praecox</td>
<td>24</td>
<td>36</td>
<td>98</td>
<td>12.2</td>
<td>10.2</td>
<td>13.3</td>
<td>42.9</td>
<td>21.4</td>
<td>44.9</td>
</tr>
<tr>
<td>Obstructive lymphedema</td>
<td>12</td>
<td>17*</td>
<td>42</td>
<td>16.7</td>
<td>14.3</td>
<td>23.8</td>
<td>35.7</td>
<td>9.5</td>
<td>23.8</td>
</tr>
<tr>
<td>Miscellaneous types of</td>
<td>6</td>
<td>9</td>
<td>17</td>
<td>0</td>
<td>11.8</td>
<td>5.9</td>
<td>70.5</td>
<td>11.8</td>
<td>47.0</td>
</tr>
<tr>
<td>lymphedema</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>42</td>
<td>62</td>
<td>157</td>
<td>12.1</td>
<td>11.5</td>
<td>15.3</td>
<td>43.9</td>
<td>17.2</td>
<td>39.5</td>
</tr>
</tbody>
</table>

* Includes one upper extremity.
quency with which the various patterns were observed in this group are shown in table 2. Injections into 5 extremities of 4 patients failed to show at least one pattern of type 3 or 4. All of these five extremities had been edematous for less than six months. Patterns of types 3 and 4 were seen often in extremities which had been edematous for six months or longer. There was also a direct, though less striking, correlation between the degree of edema at the time the injections were made and the frequency of patterns of types 3 and 4.

Islands were observed much less frequently in obstructive lymphedema than in lymphedema praecox.

Miscellaneous Types of Lymphedema. Two patients with primary inflammatory lymphedema, three with secondary inflammatory lymphedema and one with lymphedema owing to prolonged dependency of the legs from arthritic contractures of the knees are included in this group. Three were females. The ages of the six patients varied from 20 to 69 years with a mean of 41 years. The duration of edema at the time the injections were made ranged from 7 months to 10 years with a mean of 4 years. All extremities were edematous when the injections were made, although only two were markedly so (grade 4). The frequency with which various patterns were observed is shown in table 2. Only one extremity failed to show at least one pattern of type 3 or 4, and this extremity was injected only once. A high incidence of islands was noted in this group.

Patterns Observed in Extremities with Edema Other Than Lymphedema

Acute Thrombophlebitis. Seventeen patients with acute thrombophlebitis of one or both lower extremities were included in this study. Ten were males. The ages of all ranged from 16 to 69 years with a mean of 49 years. The diagnosis was acute iliofemoral thrombophlebitis in 14 extremities and thrombophlebitis deep in the calf in four. The duration of symptoms at the time that the injections were made varied from one day to three weeks with a mean of 10 days. Five extremities were not edematous at the time of the injections and in three the pitting edema was graded as 3 or 4. The frequency with which the various patterns were observed is shown in table 3. No injections resulted in patterns of type 3 or 4.

Chronic Venous Insufficiency. Twenty-seven patients with chronic venous insufficiency of one or both lower extremities were included. Nineteen were males. The ages of all ranged from 26 to 78 years with a mean of 48 years. The duration of symptoms of venous insufficiency at the time the injections were made ranged from 1 month to 30 years; the mean was 11 years. Many of the extremities exhibited pigmentation characteristic of chronic venous insufficiency and a few showed stasis ulcers. Previous treatment had rendered 28 extremities free of pitting edema at the time of the injections. In only two extremities was the pitting edema graded 3 or 4. The frequency with which the various patterns were observed is shown in table 3. No pattern of type 4 was observed. A total of 11 injections into 10 extremities of nine patients resulted in patterns of type 3. Islands were observed after nine injections. All 11 of the patterns of type 3 were observed in extremities which had no edema or only slight edema (grade 1) when the injections were made. Nine of the 11 patterns of type 3 were observed in extremities in which the symptoms of chronic venous insufficiency had been present for 10 or more years.

Lipedema. Ten patients with lipedema were included. All were women and their ages ranged from 35 to 59 years with a mean of 50 years. The duration of symptoms at the time the injections were made varied from 1 to 50 years with a mean of 23 years. Although all patients had the thick ankles and fat legs characteristic of this condition, only two had pitting edema when the injections were made. The frequency with which the various patterns were observed is shown in table 3. A total of seven patterns of types 3 and 4 were observed in five legs of three patients. Islands were noted after three injections. Two of the three patients whose legs showed patterns of types 3 and 4 had had lipedema for 25 years. The third had had symptoms for 13 years. In two of the five legs in which patterns of types 3 and 4 were seen pitting edema was present when the injections were made.
Simple Orthostatic Edema. The lower extremities of five patients with simple orthostatic edema were injected. This syndrome is characterized by mild to moderate pitting edema of the ankles related to orthostatism and often aggravated by warm weather, menopause, and the menopause. No objective evidence for other causes of edema is found. Two of the patients included in this group would actually have been classed as normal except for a history of minimal and extremely intermittent swelling of the ankles noted at the end of a day. The other three patients had more persistent and troublesome edema of the ankles. All the patients were women from 25 to 58 years of age with a mean age of 46 years. Symptoms had been present from 7 months to 20 years with a mean of 8 years. Only one patient had demonstrable pitting edema of the legs at the time the injections were made. The frequency with which various patterns were observed is shown in table 3. No pattern of type 4 was observed and only two injections resulted in patterns of type 3 (both with islands). These two patterns were noted in the legs of a 24-year-old woman who had experienced intermittent ankle edema for four years but no edema was present at the time of the injections.

Congestive Heart Failure. Nineteen patients with congestive heart failure severe enough to cause ankle edema were included. Fourteen were males. The ages of all patients ranged from 36 to 81 years and the mean was 55 years. Edema had been present continuously or intermittently for one day to five years. The mean duration was 10 months. Prior treatment had rendered the extremities of four patients free of edema before the injections were made, but 19 extremities had pitting edema of grade 3 or 4. The frequency with which various patterns were observed in this group is given in table 3. Only two injections resulted in patterns of type 3, and no patterns of type 4 were observed. One of the patterns of type 3 was seen in the leg of a 62-year-old woman who had had edema of the ankles secondary to congestive heart failure (hypertensive) for 13 months. The pitting edema was classified as grade 1 when the injection was made. The other pattern of type 3 was observed in the leg of a man, aged 71 years, who had noted edema of the ankles for only one day prior to the injection. The pitting edema was classified as grade 2 when the injection was made.

Nephrotic Syndrome. The lower extremities of six patients with nephrosis were injected. Four of these patients were males. The ages of the six varied from 30 to 63 years with a mean of 44 years. The duration of edema at the time the injections were made varied from 10 weeks to 2½ years with a mean of 14 months. All extremities were severely edematous (grade 3 or 4) when the injections were made. The frequency with which the various patterns were observed in these patients is shown in table 3. One pattern of type 4 and five of type 3 were encountered after injections into six extremities of four patients. Islands were seen after four injections. Three of the five patterns of type 3 were seen in extremities that had been edematous for less than 6 months. Patterns of type 1 were observed in the legs of the patient who had had edema for two and one-half years.

Miscellaneous Conditions. Two patients had
pitting edema of the lower extremities owing to hypoproteinemia from causes other than nephrosis and cirrhosis of the liver. The duration of edema was less than three months in both cases and all patterns observed were of types 0 and 1.

One patient had had edema of the ankles intermittently for six months owing to therapy with hydralazine (Apresoline). No edema was present at the time of the injections, and all patterns observed were of type 1.

Two patients who had massive edema of the lower extremities secondary to decompensated hepatic cirrhosis were included. Patterns of type 3 were noted in three of the four extremities and islands were noted in one. The edema had been present for three months in one case and 11 months in the other.

Patterns Observed in Apparently Normal Companion Extremities of Patients with Unilateral Edema

Thirty-nine patients had unilateral edema of the lower extremities and their apparently normal extremities were injected as well as the edematous ones. In only one of these apparently normal extremities was a pattern of type 4 noted. The disease in the opposite leg of this patient was lymphedema praecox. One pattern of type 3 developed in the apparently normal leg of a patient with acute iliofemoral thrombophlebitis in the opposite leg. Patterns of type 2 were noted in the apparently normal legs of two patients who had unilateral lymphedema praecox. In the remaining 35 patients with unilateral edema, all patterns observed in the apparently normal extremities were of types 0 and 1.

Comment

We do not claim to be measuring lymph flow by the technic described. It is our assumption, however, that the reticular network surrounding the central wheal represents the ramifications of cutaneous lymphatic capillaries which become filled with the fluorescent solution during the injection. Specimens of lymphedematous skin and subcutaneous tissue obtained at operation were injected repeatedly and a typical reticular pattern was obtained; unfortunately however, the riboflavin solution was lost in the process of preparing the tissue for sections. As a result microscopic confirmation that the solution of riboflavin is actually in cutaneous lymphatic capillaries is lacking. Hudack and McMaster, however, have injected India ink and gelatin into the skin and have found on examining such specimens microscopically that the superficialplexus of lymph vessels and the deeper-draining trunks are filled.

Hudack and McMaster also emphasized that the lymphatic capillaries filled immediately after the injection. Our observations confirm this. These investigators were able to demonstrate a cutaneous network of lymphatic capillaries after nearly every intradermal injection of nonfluorescent dyes, and they consequently stated that, because of the extensive intertwining network of lymphatic capillaries in human skin, every intracutaneous injection was to some extent an intralymphatic injection.

Under the conditions of our investigation, however, we found that cutaneous lymphatic capillaries were filled poorly or not at all in normal as well as in many edematous extremities. In sharp contrast, we found that extensive capillary networks were demonstrated with relative ease in extremities affected by lymphedema. This observation also has been made by Kinmonth and Taylor while using a nonfluorescent dye, patent blue V.

This naturally leads to the speculation that dilated capillaries of an incompetent lymphatic system are an easy target for the needle and become filled with the solution of riboflavin. Normal lymphatic capillaries, on the other hand, being empty and collapsed are not so easily penetrated by the needle and hence not so frequently or extensively filled. It is conceivable that they do become filled with the solution but in the absence of lymphostasis any dye injected directly into the capillaries is so rapidly removed that it is not visible by the method which we employed.

It has been shown that in most types of edema, regardless of cause, lymphatic capillaries are wide open and distended with the edema fluid. Yet in this study patterns of
types 3 and 4 were observed with no significantly greater frequency in extremities edematous from acute thrombophlebitis and congestive heart failure than in normal extremities. In extremities edematous from chronic venous insufficiency patterns of type 3 were observed only rarely except in patients whose symptoms were of more than 10 years' duration, and it is known that lymphatic incompetency is occasionally a sequel to venous insufficiency of long standing. In lymphedema praecox, however, in which the primary condition is incompetency of the lymphatic system, patterns of types 3 and 4 were observed as frequently in the early stages as in the more chronic stages and irrespective of whether or not edema was present when the tests were performed. In fact, we, and also Kinmonth and Taylor, have observed rather extensive patterns of lymphatic capillaries in the apparently normal and non-edematous legs of some patients with unilateral lymphedema praecox. It seems, therefore, that mere distention of lymphatic capillaries does not predispose to their ready demonstration after an intracutaneous injection unless there is also a factor of incompetency or lymphostasis.

Inconsistent with this reasoning were the results in patients with nephrotic syndrome, for 25 per cent of the injections into the edematous extremities of nephrotic patients resulted in patterns of types 3 and 4. This is considerably more than in normal extremities but considerably less than in extremities affected by lymphedema. There is no reason to believe that lymphatic incompetency is a factor in nephrotic edema and, in fact, McMaster has demonstrated that lymph flow is markedly increased in the skin of extremities edematous from nephrosis. It is difficult to explain why the capillaries of an apparently competent lymphatic system become filled so frequently in nephrotic edema but fail to fill so readily in extremities with other types of edema, unless it is due to the fact that all of the extremities with nephrotic edema that were studied were massively edematous at the time of the injections while many of the extremities in the other categories were not edematous or only slightly so when the injections were made.

Unfortunately we did not have the opportunity to repeat the injections in patients with nephrosis to determine whether or not lymphatic capillaries could be demonstrated as readily after edema had subsided.

The failure to demonstrate patterns of types 3 and 4 in the cases of extremely chronic lymphedema praecox (74 and 23 years' duration) may be due to obliteration of the cutaneous lymphatic capillaries by proliferation of fibrous tissue in the chronic stages of lymphedema.

Too little is known about the pathophysiology of lipedema and simple orthostatic edema and too few cases of edema due to hypoproteinemia and cirrhosis of the liver were studied to justify comment at this time.

The high incidence of islands demonstrated after injections into lymphedematous extremities tends to confirm McMaster's opinion that they are indicative of lymphatic incompetency. McMaster rarely found islands after injections into extremities with nephrotic edema, but described a high incidence in congestive heart failure. We have found just the opposite.

**Summary**

A method for demonstrating cutaneous lymphatic capillaries by injecting a fluorescent dye (riboflavin) intradermally is described. The patterns observed in the skin under ultraviolet light after such injections are classified as types 0 to 4, the former indicating no demonstration of lymphatic capillaries while the latter indicates maximal demonstration. Patterns of type 4 were not seen in normal extremities and only 1.5 per cent of the injections into normal extremities resulted in patterns of type 3. In contrast, 17 per cent of the injections into extremities with lymphedema showed patterns of type 4 and 44 per cent showed patterns of type 3.

Patterns of types 3 and 4 were observed much less frequently in extremities with edema owing to causes other than lymphedema. Only in nephrotic edema did the frequency of patterns of types 3 and 4 (25 per cent) approach that seen in lymphedema.

Certain of the data presented indicate that
extensive filling of the lymphatic capillaries (as in types 3 and 4) indicates lymphatic incompetency and not just lymphatic distention. However, further observations are necessary before the value of the fluorescent wheal test in the differential diagnosis of peripheral edema can be definitely determined.

**SUMMARIO IN INTERLINGUA**

Es describite un metodo pro demonstrar cutanee capillares lymphatic per medio del injection intradermal de un colorante fluorescente (riboflavina). Le configurationes observate in le pelle sub le lumine ultraviolette post tal injectiones eseva classificate como typos 0, 1, 2, 3, e 4. Le prime de iste typos habeva nulle demonstration de capillares lymphatic; le ultime habeva un demonstration maximal. Configurationes del typo 4 non eseva trovate in extremitates normal. Solmente 1,5 pro cento del injectiones in extremitates normal resultava in configurationes del typo 3. Del altere latere, 17 pro cento del injectiones in extremitates con lymphedema monstrava configurationes del typo 4, e 44 pro cento monstrava configurationes del typo 3.

Configurationes del typos 3 e 4 eseva observate multo minus frequentemente in extremitates con edema debite a causas altere que lymphedema. Un exception es le edema nephrotic. In illo le frequentia del configurationes typo 3 e typo 4 (25 pro cento) se approximate al frequentia de iste typos in lymphedema.

Certes del datos presentate indica que le...
Fluorescent Patterns of Intracutaneous Wheals in Normal and Edematous Extremities
RAY W. GIFFORD, JR., JOHN H. WINDESHEIM, J. EARLE ESTES, JR. and GRACE M. ROTH

Circulation. 1956;13:515-523
doi: 10.1161/01.CIR.13.4.515
Circulation is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 1956 American Heart Association, Inc. All rights reserved.
Print ISSN: 0009-7322. Online ISSN: 1524-4539

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://circ.ahajournals.org/content/13/4/515

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published in Circulation can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office. Once the online version of the published article for which permission is being requested is located, click Request Permissions in the middle column of the Web page under Services. Further information about this process is available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at:
http://www.lww.com/reprints

Subscriptions: Information about subscribing to Circulation is online at:
http://circ.ahajournals.org/subscriptions/