

**BRIEF COMMUNICATION****EFFECT OF MASSAGE AND TEMPERATURE ON THE PERMEABILITY OF INITIAL LYMPHATICS****Shao Xujian**

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Although changes in the permeability of initial lymphatics in a variety of abnormal physiologic conditions have been studied (1-8), little data exist on the effects of massage and temperature elevation. Accordingly, in this experimental study the junctions within the initial lymphatics were examined when the rabbit hindlimb was either massaged or the ambient temperature was varied from 0-54°C.

**MATERIALS AND METHODS**

White New Zealand rabbits (approximately 2kg BW) were anesthetized with urethane (1g/kg). Patches of limb skin were chosen for microinjection of China ink containing carbon particles (*Fig. 1*). Microinjection refers to a 5 min intradermal instillation of a trace solution (in this case, 0.025ml of 20% China ink) using a specially designed tiny injector and needle to disturb minimally tissue pressure (7,8). The rabbits were then divided into five groups:

Group 1. Normal: Specimens were excised 10 minutes after microinjection.

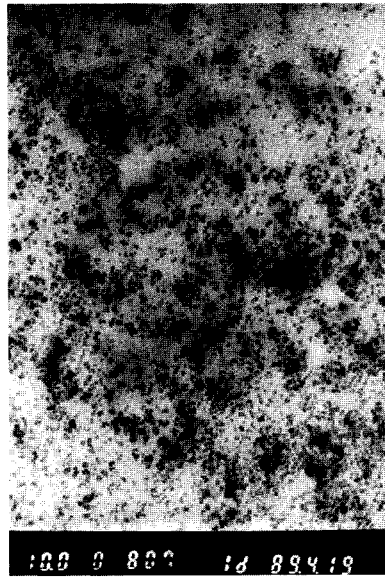
Group 2. Massage: Hindlimb was gently compressed promptly after microinjection and lasted for 10 minutes. Skin specimen was thereafter obtained.

Group 3, 4, 5. After microinjection, the limbs were immediately put into a

water bath at a temperature of 54°C, 20°C, and 0°C, respectively for 10 minutes each. Skin specimens were then obtained.

The excised skin specimens were subsequently examined by electron microscopy (Hitachi 800A).

To compare the open and closed junctions quantitatively, in each group we randomly counted 300 lymphatic endothelial junctions (open and closed including narrow and tight ones).



*Fig. 1. Carbon particles from China ink (x15,000).*

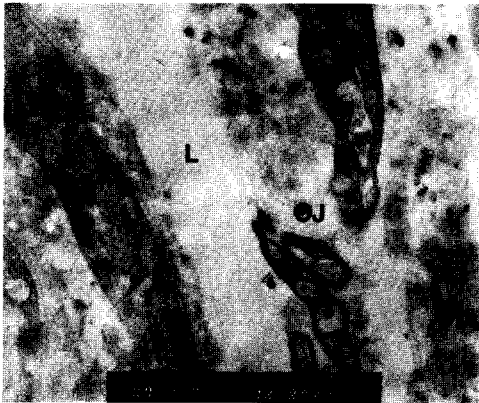


Fig. 2. Normally carbon particles are seldom seen in the cytoplasm ( $\times 45,000$ ). L=lymphatic lumen; OJ=open junction.



Fig. 3. After massage, carbon particles (C) are seen entering the open junction (OJ) ( $\times 8,400$ ).

## RESULTS

The number of carbon particles in the initial lymphatics of groups 2 and 3 (massage and  $54^{\circ}\text{C}$ ) were quantitatively greater when compared with the other three groups (Figs. 2-4). No vesicles were seen within the endothelium despite accumulation of carbon particles in the cell

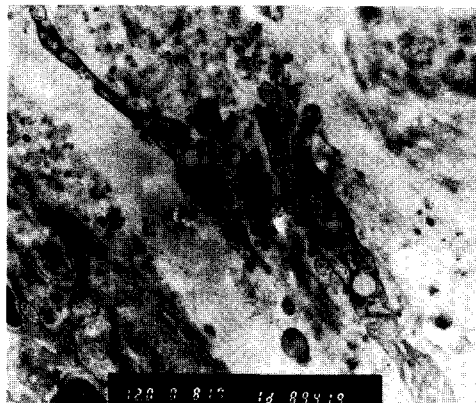


Fig. 4. With hyperthermia ( $54^{\circ}\text{C}$ ), numerous carbon particles (C) are evident in the open junction (OJ) ( $\times 16,400$ ). L=lymphatic lumen.

cytoplasm. Table 1 summarizes the ultrastructural findings of the lymphatic capillary junction after massage and varying the ambient temperature.

## DISCUSSION

Although carbon particles can enter the initial lymphatics by three different routes (through open junctions, via endothelial vesicles, or directly through endothelial cells) the open junctions were deemed the most important portal particularly since vesicles were not seen within the endothelium. Accordingly, the lymphatic entry of carbon particle and the ultrastructural appearance of initial lymphatics were used as indicators of lymphatic capillary permeability. In this regard, a direct relationship between ambient temperature and permeability of the initial lymphatics was found. The number

Table 1  
Ultrastructure of Initial Lymphatics

Group	Open Junctions (#)	Closed Junctions (#)	Total (#)	p value*
1. control	80	220	300	
2. massage	88	212	300	>0.05
3. $54^{\circ}\text{C}$	211	89	300	<0.01
4. $20^{\circ}\text{C}$	65	235	300	<0.05
5. $0^{\circ}\text{C}$	48	252	300	<0.01

\*compared with control

of open junctions increased with elevated temperature and dramatically so with marked hyperthermia (i.e., 54°C). The increased density of carbon particles in the initial lymphatics supported these morphologic findings. These preliminary ultrastructural data may account for the reported improvement in edema from lymphatic insufficiency following elevation in ambient temperature and external massage.

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