

## Lymph Flow in Human Leg

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### Summary

A little bit of RISA (0.01–0.02 ml) was injected into a lymphatic at the back of a human foot in supine and/or sitting position, and the radioactivity curves were obtained at the inguinal and/or at the middle of the thigh. Radioactivity curves at the inguinal region showed stepwise rise with the frequency of about 1/min. in subjects without edema and steep rise without staircase in patients with cardiac edema. Radioactivity curves at the middle of the thigh showed many spiky waves with the frequency of about 1/min. in supine subjects without edema, which were increased in frequency, duration and/or height in sitting subjects without edema and also in supine and sitting patients with cardiac edema.

Therefore, it may be said that there are rhythmic lymph flows in lower leg of subjects without edema and of patients with cardiac edema not only in supine but also in sitting position, and also that lymphatic contractility plays some role in propelling lymph in human leg.

*McMaster* (1) regarded "the streamer" as a measure of lymph flow in skin, which appeared in normal subjects in lying position after injecting intradermally very small amount (0.02 ml) of dye. In normal subjects seated quietly with the feet resting on the floor, he could find no streamer in the lower dependent legs. From this he denied the presence of lymph flow in the lower dependent legs and assumed that in man, rhythmic contractility of the lymphatics are not playing an important role in propelling a lymph in man. He also denied the presence of lymph flow in the extremities of cardiac edema, because he could not find any streamers.

However, in our experiences, streamers were observed almost always in the dependent lower leg of normal subjects and also in most of the legs of cardiac edema. Dye-injection method seems to be lacking reproducibility to some extent, may be due to technical difficulty in injecting dye intradermally under approximately the same pressure as that existing in the tissue, and also in making the position of needle tip in the same depth of the skin every time.

Clearance rate of subcutaneously injected RISA was rapid in cardiac, nephrotic and hepatic edema and slow in lymphedema (2, 3). From this it was assumed that lymph flow was rapid or increased in cardiac edema as in nephrotic and hepatic edema.

In tissue clearance of RISA, the subjects are hospitalized and kept in bed as quiet as possible. However, as the observations are carried out 2 to 3 days long, effect of the movement of the subjects on the lymph flow may not be negligibly small. Therefore, it may be difficult to compare the results by dye-injection method with those by tissue clearance of RISA.

Rhythmic contractility of lymphatics has been observed in many mammals since many years ago, but it has been reported only in several papers (4) in human beings, where it was observed visually in operated tissue or by cine-lymphangiography. However, operation or infusion of large amount of radiopaque, e. g. foreign body, with high pressure may change proper lymph flow or influence the behaviour of lymphatics very much. Therefore, it seems still obscure, whether rhythmic contractility is found or not in the experiment under more physiological condition. *Courtice* said in his book (5) as followings: although some of the lymphatic vessels in man have been shown to exhibit the property of intrinsic rhythmic contractility as an aid in the propulsion of lymph, little is known of the phenomenon in the vessels of the leg either in normal or in abnormal conditions. It may be that this activity is normally low in man and that it varies in different stages of edema caused by congestive cardiac failure.

*Donini et al.* (6) injected 0.1 ml of RISA into the lymphatics at the back of a resting human foot in lying position and recorded radioactivity

at the inguinal region of the same side. He observed stepwise rise of the radioactivity in normal subjects and steep rise without staircase in cardiac edema. He postulated from this that there may be rhythmic lymph flow in normal human leg and rapid, increased lymph flow in leg of cardiac edema. However, as the amount of injected RISA was 0.1 ml, e. g. 100 mm<sup>3</sup>, its effect on lymph flow or wall of the lymphatics may not be negligible, because diameter of the lymphatics of the foot used for injection is about 1 mm or smaller.

Therefore following experiments were undertaken (7, 8). Subjects were those without edema and with edema of various origin in resting supine and sitting position. A little bit of RISA (0.01–0.02 ml) was injected into the lymphatics at the back of a foot and radioactivity was recorded continuously for about 30 to 40 minutes at the inguinal region or at the middle of the thigh on the same side. The room temperature was 23° to 24° C.

a) Subjects without edema. The radioactivity curve at the inguinal region showed similar pattern to that of *Donini*, e. g. stepwise rise in supine position scores of seconds to a few minutes after injection of RISA, and the duration of the staircase was about one minute. The radioactivity curve at the middle of the thigh began to rise scores of seconds to a few minutes after injection of RISA and after arriving the peak fell gradually. Sharp, tall spike waves were superimposed on the curve at the interval of about one minute in supine position. In sitting position, the spike waves were higher, wider and more frequent than those in supine position.

The stepwise rise in radioactivity at the inguinal region may be due to rhythmic lymph stagnation in the inguinal lymph nodes and the rhythmic spike waves may be due to rhythmic lymph flow and may also be attributed to rhythmic contractility of lymphatics, because they were asynchronous with respiratory move-

ment, arterial pulse. Injection of RISA into lymphatics may initiate lymphatic contraction, however its amount is about 0.01 ml, about 1/10 of that of *Donini*, its effect may be negligible.

b) Cardiac edema. The radioactivity curve at the inguinal region showed steep rise without staircase like that of *Donini*, and the radioactivity curve at the middle of the thigh showed also many spike waves with increased height and frequency both in supine and sitting position. Almost similar pattern was observed in renal and hepatic edema.

Therefore, it may be said that there is a lymph flow in dependent lower leg of normal subjects in sitting position and in the leg of cardiac edema and also that lymphatic contractility plays some role in propelling lymph in human leg.

#### References

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