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Concept of Body Fluid Circulation

(Ichimai Kishomon — One-Page Petition)*)

Yasuyosi NISIMARU

Tokyo Jikei-kai Laboratories of Angiology, 1-39 Umeki-cho, Kure 731-44, Japan

Dedicated to Her Imperial Highness Princess Kikuko Takamatsu, President of the Tokyo Jikei-kai Society

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FOREWORD

In 1927 I visited my alma mater, the Tokyo Jikei-kai Medical School before starting on a tour abroad. On seeing me in the anatomical department temporarily built after the Kanto earthquake disaster, Dr. Harujiro Arai said to me, "A thesis of one or two pages is sufficient; the rest is fabrication." Twenty-four years later, when I visited Chion-in Temple in Kyoto with the ashes of my beloved aunt Aki Fukuba to consign it to the temple, I bought for reminiscence a book, "Code Talked by Saint, the Originater" by Venerable Honen. In this book, there were the words 'Ichimai kishomon' (one-page petition)[1]. This is a concept summarized in 253 words by Honen on 23 January 1212 just two days before his death on what he gained through his 80 years of devotion to the faith.

This reminded me of the one- or two-page thesis which Dr. Arai advised, and W. H. Gantt's words, "His epitaph might be written in his own words," in I. P. Pavlov's biographical sketch included in "Lecture on Conditioned Reflexes."[17] The principle of blood circulation might be the epitaph for W. Harvey and conditioned reflexes might be the one for Pavlov. Then, I thought it might be desirable that natural scientists should also write an 'Ichimai kishomon' on his life study.

HISTORICAL NOTE

Hippocrates (B.C. 460–375) of Greece believed that health was maintained by harmony between four body fluids, namely, blood, mucus, yellow bile and black bile. This theory lacks a concept of flow. Erasistratus (B.C. 310–250) of Alexandria, from the results of his autopsy studies, stated that blood flowed through the venous system and that pneuma flowed through the arterial and nervous systems. While, Galen (A.D. 131–210) of Rome thought from vivisection that blood and pneuma flowed through the arterial and nervous systems because the blood spouted from the incision of the artery. In the latter two theories, there is a concept of flow.

William Harvey (1578–1657) of England wrote in 1628 in his "De Motu Cordis"[3] that "... there are three points coming for proof from which I believe the truth will necessarily follow and be clearly evident: First, blood is constantly being transmitted from the vena to the arteries by the heart beat in such amounts that it cannot be furnished by the food consumed. Second, blood is forced by the pulse and by the arteries continually and steadily to every part of the body. And likewise third, the veins continually return this blood from every part of the body to the heart." He thought by comparative experiments on living animals that body fluid consisted only of blood; the heart beat was the only cause for blood flow; and the blood vessels were just ducts. In other words, he arrived at the concept of blood circulation.

On the other hand, Claude Bernard (1813–1878) regarded body fluid as internal environment and wrote "La fixté du milieu intérieur est la condition de la vie libre"[2].

Regarding the concept of body fluid flow, there still was a generally accepted idea that only blood circulates, even around 1931, 303 years after Harvey's study. Then, we 140 collaborators examined with the new methods each of the study subjects such as the heart, arteries, blood capillaries, veins, tissue spaces, lymph

*) 西丸和義：体液循環の概念（一枚起請文）

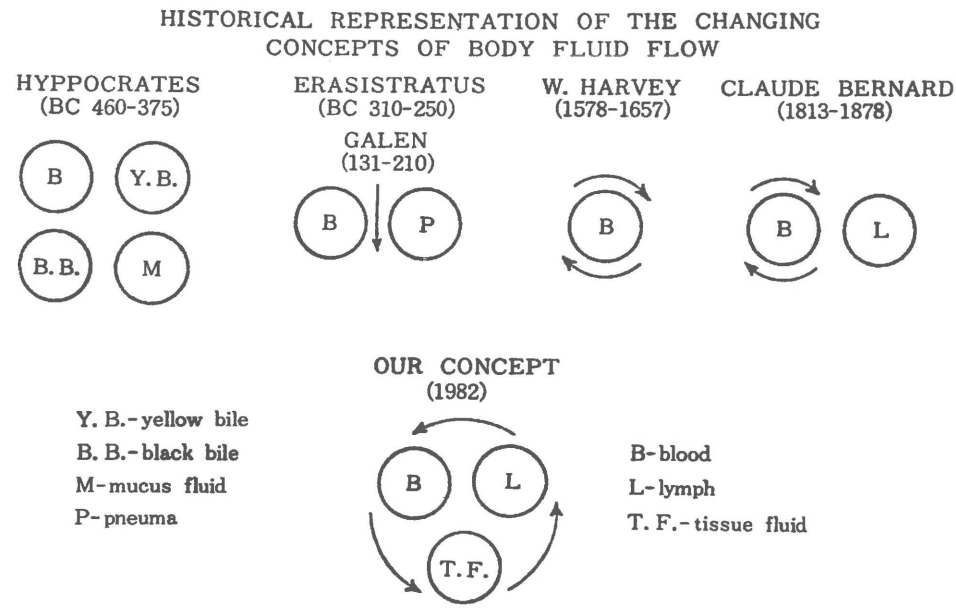
capillaries, lymphatics, vasomotor nerves, body fluid, etc. to confirm the knowledge arrived at up to the present time through the investigations of senior scientists, and added new findings. Our research papers[4] during the past 50 years, which amounted to more than 1000, can be classified as follows: 1) Comparative physiological studies of body fluid flow[10], 2) Studies on blood capillaries[9], 3) Studies on lymphatics[8,16] 4) Studies on vasomotor nerves[7], 5) Contarctility of the vessels and its mechanism[12], 6) Body fluid flow among tissue spaces[11], 7) Body fluid flow from blood capillaries to lymph capillaries[13], 8) Interaction between the heart, blood vascular and lymphatic systems for body fluid flow[14], 9) Mechanism of peripheral circulation[5], and 10) Concept of body fluid circulation[6]. Further, these were compiled into a 58-page paper, "Basis of Angiology—A Concept of Body Fluid Circulation"[15]. According to these studies, 1) Blood, tissue fluid, and lymph are linked and are essentially one and the same extracellular fluid; 2) Body fluid flows from the blood capillaries to the tissue spaces and in part from the tissue spaces to the blood capillaries again, and partly from the tissue spaces to the lymph capillaries; 3) The lymphatics are almost the same as the veins in their structure and function, both of which act toward returning body fluid to the heart; 4) The tissue spaces serve as routes from the blood capillaries to the lymph capillaries; 5) There are mutual control mechanisms for the flow of body fluid between the heart, blood vessel and lymphatic systems. From these we arrived at the following concept of the body fluid circulation. Herewith I will present it as my 'Ichimai kishomon'.

CONCEPT OF BODY FLUID CIRCULATION

Ichimai kishomon

Body fluid is extracellular fluid in the body, namely, blood, tissue fluid and lymph. It leaves the heart and returns again to the heart after circulating through various tissues. The main force of flow is due to hydrostatic difference produced by the contractile actions of the heart, vascular walls and the surrounding tissues, and due to the permeability of blood and lymph capillary walls and physical and chemical difference of the body fluid divided by these capillary walls. The heart is the center of body fluid circulation and the tissue spaces are the periphery.

Mechanism of the body fluid circulation includes pumping regulation by the heart, pressure and velocity regulation by the aorta, distribution



control by the medium and small arteries, fluid flow control by the minute blood and lymph vessels, volume control by the spleen, liver, lungs, veins and lymphatics, and finally back flow regulation by the veins and lymphatics. With coordination of these functions the body fluid circulates smoothly through the whole body according to the condition of the body.

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