



## **Traditional Asian Medicine Meridians:**

### **The Primo-Vascular System (PVS) and Bonghan Corpuscles and Ducts**

The first documentation that clearly describes the meridians was the *Huangdi Neijing* (given the title *The Yellow Emperor's Classic of Medicine* in one of the latest translations), dating from about 100 BCE. This description has been traditionally accepted and used as a basis for acupuncture theory and practice for over 2000 years. Since the early 1950s, researchers have tried to prove the physical existence of these meridians. Much of acupuncture's scientific skepticism is partly due to the unknown anatomical foundation for the existence of meridians. The Standard International Acupuncture Nomenclature proposed by the World Health Organization, and based on TCM texts, describe 12 organ meridians and eight extra-meridians – 20 meridians in all. The anatomic structure of meridians has remained undiscovered till the 1960s.

Bong-Han Kim, a professor at the Pyongyang Medical School in Seoul, North Korea, embarked on scientific research to discover the substratum of the meridian system (*Kyungrak* in Korean). While head of the Department of Physiology, Kim announced his discovery of this anatomical substratum, calling it the "Substance of Kyungrak," on August 18, 1961, which he then published in 1962. Kim then proposed a system he called the Bonghan Ducts as the physical basis for the Traditional Chinese meridian system. Kim subsequently published 6 articles and a book on his research from 1962 to 1965.<sup>1-7</sup>

Kim described nodes and ducts that corresponded to traditional acupuncture points and meridians. He called these nodes and ducts Bonghan corpuscles and Bonghan ducts after his

own name. In the 1962 publication, he wrote that the substrate of the meridian system “consists of bundles of tubular structures and it is clearly distinguishable from nervous, blood vessels and lymph systems in histological and experimental-biological characters” and “the diameter of the tubular structures range between 20 and 50  $\mu\text{m}$ .”

Kim used several experimental methods in determining this such as anatomical methods, histological methods, radioautography, histochemical methods, blue staining methods, and radioactive dosimetry. In his analyses of the Bong-Han system Kim found that the transparent fluid inside the ducts contains more nucleic acids, especially DNA, than any other known tissue. The Bong-Han ducts also contain *sanals*, meaning “live egg” in Korean, which seem to have a function equivalent to that of stem cells. Kim described these sanals, renamed *primo microcell* or *P-microcell*, as having hematopoietic functions as well as the ability to regenerate injured tissues and heal wounds.

Bong-Han Kim’s work was largely ignored until in 2002 at the Seoul National University a team of researchers led by Professor Kwang-Sup Soh investigated further and conclusively confirmed that this system represented the physical construct of the acupuncture system.<sup>8, 9, 10, 11</sup> They renamed it the Primo Vascular System (PVS) and have shown it exists in the same locations as the traditional meridian system acting as a third circulatory system after the cardiovascular and lymphatic systems. Numerous others since have further described these Primo vessels as having bioelectrical activity, excitatory conductivity, and mechanical motility.<sup>12, 13, 14, 15, 16</sup> Over several investigations have discovered these primo-vessels (Bonghan ducts) and primo-nodes (Bonghan corpuscles) in various animal tissues and organs - mouse, rat, and rabbits.

According to this research the PVS integrates the features of the cardiovascular, nervous, immune, and hormonal systems. It provides a physical substrate for the acupuncture points and meridians. Announcements of the morphological architectonics and the function of the PVS fundamentally changed the basic understanding of biology and medicine because the PVS is also involved in the development and the functions of living organisms.

Korean researchers discovered a liquid, called “the primo fluid”, that circulates in the PVS. Its flow is slower than blood flow and lymphatic flow. The primo fluid flows in one direction, attending blood flow. The liquid flow depends on the heartbeat and on the pressures of the blood and the lymph. The PVS fluid has DNA outside the cell nucleus. The biochemical components of primo fluids are DNA, RNA, nitrogen, fats, reducing sugar, hyaluronic acid, 19 free amino acids, and 16 free mononucleotides. The routes of flow are interconnected, but relatively independent. Primo fluid circulates only in a specified region, but it can also be transmitted through interconnections with other pathways.

The subvessels of the PVs are composed of endothelial cells with rod-shaped nuclei, smooth muscle cells, and adventitia. Fiber structures and amorphous substances exist among the subvessels. A membrane surrounds the whole primo vessel. The constituents of the PN are the subvessels and various cells. The subvessels are densely distributed, enlarged, and connected to each other. Kim developed his idea for the PVS by adding interior and exterior PVs.

As previously mentioned, the PVs have bioelectrical activity, excitatory conductivity, and mechanical motility. The electrical activity changes in relation to stimuli to the PVs. The PVs have mechanisms to circulate the primo fluid actively. All nuclei of the tissue cells are connected to fine terminal subvessels, and these subvessels are connected to the primo vessels in a body's organs. The PNs in an organ are connected to the organ's tissue cells within a specified range. All PNs for the organs are connected to all meridians. The meridian structures start and end at the PNs for the organs.

It has taken over 2000 years to validate the meridian system originally described in the *Huangdi Neijing*. Kim and Soh's research toward the meridian system has now fostered many others to further explore the PVS. The discovery of the PVS in intravascular and extravascular spaces, in the central and peripheral nervous systems, on the surface of and within viscera, in cutaneous layers, and in most body systems, may signify a novel and complete morpho-dynamic system, with the potential to reshape paradigms in medicine and especially energy medicine.

This video explains the PVS using a staining dye injected into the body. In their video example, they chose to look at a section of PVS inside of a Lymph vessel because the normally transparent tissue will clearly elucidate with the dye. The width of these tubes is 20-30 micrometers; contrast that with the thickness of human hair 60-120 micrometers.

<https://www.youtube.com/watch?v=yPQZXfPj7TI&feature=youtu.be>

Thornton Streeter, a biofield scientist created an excellent presentation on the PVS and its relations to both TCM and the Nadis of the Yogic/Ayurvedic traditions.

<https://www.slideshare.net/thorntonstreeter/primo-vascularmeridian-system-2016>

### **Other noteworthy discoveries:**

Recent research at a joint Harvard-MIT Biomedical imaging center used fMRI to see changes in the brain as a result of needling acupoints on various meridians in the body. (Functional magnetic resonance imaging or functional MRI (fMRI) measures brain activity by detecting changes associated with blood flow.) Incredibly, they were able to show deactivation of the limbic brain and amygdala through needling the acupoints Large Intestine 4, Liver 3 and Stomach 36.

<http://www.nmr.mgh.harvard.edu/acupuncture/PPG/projects/index.php>

Further Chinese research has confirmed their findings.

<https://www.ncbi.nlm.nih.gov/pubmed/18684074>

### **References**

1. Kim BH. *Great Discovery in Biology and Medicine: Substance of Kyungrak*. Pyongyang, North Korea: Foreign Languages Publishing House; 1962.
2. Kim BH. Study on the reality of acupuncture meridians [in Korean]. *J Jo Sun Med*. 1962; 9: 5-13.

3. Kim BH. On the Kyungrak system. *J Acad Med Sci DPR Korea*. 1963; 90: 1-41.
4. Kim BH. *On the Kyungrak System*. Pyongyang, North Korea: DPR Korea; 1964.
5. Kim BH. The Kyungrak system [in Korean]. *J Jo Sun Med*. 1965; 108: 1-38.
6. Kim BH. The sanal theory. *J Acad Med Sci DPR Korea*. 1965; 108: 39-62.
7. Kim BH. Sanals and hematopoiesis [in Korean]. *J Jo Sun Med*. 1965: 1-6.
8. Soh KS, Hong S, Hong JY, Lee BC, Yoo JS. Immunohistochemical characterization of intravascular Bonghan duct. *Microcirculation*. 2006; 13: 166.
9. Soh, Kwang-Sup. "Bonghan circulatory system as an extension of acupuncture meridians." *Journal of acupuncture and meridian studies* 2, no. 2 (2009): 93-106.
10. Soh, Kwang-Sup, Kyung A. Kang, and David K. Harrison, eds. *The Primo Vascular System: Its Role in Cancer and Regeneration*. Springer Science & Business Media, 2011.
11. Soh, Kwang-Sup. "Current state of research on the primo vascular system." In *The Primo Vascular System*, pp. 25-39. Springer, New York, NY, 2012.
12. Stefanov, Miroslav, Michael Potroz, Jungdae Kim, Jake Lim, Richard Cha, and Min-Ho Nam. "The primo vascular system as a new anatomical system." *Journal of acupuncture and meridian studies* 6, no. 6 (2013): 331-338.
13. Stefanov, Miroslav, and Jungdae Kim. "Primo vascular system as a new morphofunctional integrated system." *Journal of acupuncture and meridian studies* 5, no. 5 (2012): 193-200.
14. Ghiron, Chiara. "The Primo Vascular System as a Possible Exosomal Route Across the Body: Implications for Tumor Proliferation and Metastasis." *Journal of acupuncture and meridian studies* 12, no. 1 (2019): 25-28.
15. Chikly, Bruno, Paul Roberts, and Jorgen Quaghebeur. "Primo vascular system: a unique biological system shifting a medical paradigm." *J Am Osteopath Assoc* 116, no. 1 (2016): 12-21.

The following are selected articles on the primo-vascular system (PVS) and Bonghan corpuscles and ducts.

### PVS and Bonghan Research Articles

An, Ping, Jingxing Dai, Zhendong Su, Jung-Sun Yoo, Rongmei Qu, Sung-Woo Lee, Ki-Hoon Eom, Kyang-Hee Bae, Hesheng Luo, and Kwang-Sup Soh. "Putative primo-vascular system in mesentery of rats." *Journal of Acupuncture and Meridian Studies* 3, no. 4 (2010): 232-240.

<https://www.sciencedirect.com/science/article/pii/S2005290110600428>

Chikly, Bruno, Paul Roberts, and Jorgen Quaghebeur. "Primo vascular system: a unique biological system shifting a medical paradigm." *J Am Osteopath Assoc* 116, no. 1 (2016): 12-21.

[https://www.cecily.com/aoa/jaoa\\_mag/2016/jan\\_16/12.pdf](https://www.cecily.com/aoa/jaoa_mag/2016/jan_16/12.pdf)

Cho, Seong-Jin, Sang-Hun Lee, Wenji Zhang, Sae-Bhom Lee, Kwang-Ho Choi, Sun-Mi Choi, and Yeon-Hee Ryu. "Mathematical distinction in action potential between primo-vessels and smooth muscle." *Evidence-Based Complementary and Alternative Medicine* 2012 (2012).

<http://downloads.hindawi.com/journals/ecam/2012/269397.pdf>

Choi, Jae-Hong, Tae Hee Han, Chae Jeong Lim, So Yeong Lee, and Pan Dong Ryu. "Basic electrophysiological properties of cells in the organ surface primo vascular tissues of Rats." In *The Primo Vascular System*, pp. 243-249. Springer, New York, NY, 2012.

[https://www.researchgate.net/profile/Pan\\_Dong\\_Ryu/publication/302466169\\_Basic\\_Electrophysiological\\_Properties\\_of\\_Cells\\_in\\_the\\_Organ\\_Surface\\_Primo\\_Vascular\\_Tissues\\_of\\_Rats/links/5d881c29a6fdcc8fd6106ac0/Basic-Electrophysiological-Properties-of-Cells-in-the-Organ-Surface-Primo-Vascular-Tissues-of-Rats.pdf](https://www.researchgate.net/profile/Pan_Dong_Ryu/publication/302466169_Basic_Electrophysiological_Properties_of_Cells_in_the_Organ_Surface_Primo_Vascular_Tissues_of_Rats/links/5d881c29a6fdcc8fd6106ac0/Basic-Electrophysiological-Properties-of-Cells-in-the-Organ-Surface-Primo-Vascular-Tissues-of-Rats.pdf)

Choi, Jae-Hong, Chae Jeong Lim, Tae Hee Han, Seul Ki Lee, So Yeong Lee, and Pan Dong Ryu. "TEA-sensitive currents contribute to membrane potential of organ surface primo-node cells in rats." *The Journal of membrane biology* 239, no. 3 (2011): 167-175.

<https://link.springer.com/article/10.1007/s00232-010-9335-5>

Fujiwara, S., and S. B. Yu. "Bonghan theory'morphological studies." *Igaku no Ayumi* 60, no. 11 (1967): 567-577.

Ghiron, Chiara. "The Primo Vascular System as a Possible Exosomal Route Across the Body: Implications for Tumor Proliferation and Metastasis." *Journal of acupuncture and meridian studies* 12, no. 1 (2019): 25-28.

<https://www.sciencedirect.com/science/article/pii/S200529011830075X>

Islam, Md Ashraful, Shelia D. Thomas, Kara J. Sedoris, Stephen P. Slone, Houda Alatassi, and Donald M. Miller. "Tumor-associated primo vascular system is derived from xenograft, not host." *Experimental and Molecular Pathology* 94, no. 1 (2013): 84-90.

<https://www.sciencedirect.com/science/article/abs/pii/S0014480012001268>

Jia, Zhao-Feng, Kwang-Sup Soh, Qiang Zhou, Bo Dong, and Wen-Hui Yu. "Study of novel threadlike structures on the intestinal fascia of dogs." *Journal of Acupuncture and Meridian Studies* 4, no. 2 (2011): 98-101.

<https://www.sciencedirect.com/science/article/pii/S2005290111600149>

Jia, Zhaofeng, Kwang-Sup Soh, Qiang Zhou, Bo Dong, and Wenhui Yu. "Observation of the primo vascular system on the fascia of dogs." In *The Primo Vascular System*, pp. 71-75. Springer, New York, NY, 2012.

[https://link.springer.com/chapter/10.1007/978-1-4614-0601-3\\_10](https://link.springer.com/chapter/10.1007/978-1-4614-0601-3_10)

Jiang, Xiaowen, Hee-Kyeong Kim, Hak-Soo Shin, Byong-chon Lee, Chunho Choi, Kyung-Soon Soh, Byeung-Soo Cheun, Ku-youn Baik, and Kwang-Sup Soh. "Method for observing intravascular Bonghan duct." *arXiv preprint physics/0211086* (2002).

<https://arxiv.org/pdf/physics/0211086.pdf>

Johng, Hyeon-Min, Jung Sun Yoo, Tae-Jong Yoon, Hak-Soo Shin, Byung-Cheon Lee, Changhoon Lee, Jin-Kyu Lee, and Kwang-Sup Soh. "Use of magnetic nanoparticles to visualize threadlike structures inside lymphatic vessels of rats." *Evidence-Based Complementary and Alternative Medicine* 4, no. 1 (2007): 77-82.

<http://downloads.hindawi.com/journals/ecam/2007/413838.pdf>

Jung, Sharon Jiyeon, Sang Yeon Cho, Kyoung-Hee Bae, Sun Hee Hwang, Byung-Cheon Lee, Sungchul Kim, Byoung Se Kwon, Hee Min Kwon, Yoon-Kyu Song, and Kwang-Sup Soh. "Protocol for the observation of the primo vascular system in the lymph vessels of rabbits." *Journal of Acupuncture and Meridian Studies* 5, no. 5 (2012): 234-240.

<https://www.sciencedirect.com/science/article/pii/S2005290112001100>

Kim BH. *Great Discovery in Biology and Medicine: Substance of Kyungrak*. Pyongyang, North Korea: Foreign Languages Publishing House; 1962.

Kim BH. Study on the reality of acupuncture meridians [in Korean]. *J Jo Sun Med*. 1962; 9: 5-13.

Kim BH. On the Kyungrak system. *J Acad Med Sci DPR Korea*. 1963; 90: 1-41.

Kim BH. *On the Kyungrak System*. Pyongyang, North Korea: DPR Korea; 1964.

Kim BH. The Kyungrak system [in Korean]. *J Jo Sun Med*. 1965; 108: 1-38.

Kim BH. The sanal theory. *J Acad Med Sci DPR Korea*. 1965; 108: 39-62.

Kim BH. Sanals and hematopoiesis [in Korean]. *J Jo Sun Med*. 1965: 1-6.

Kim, Jungdae, Vyacheslav Ogay, Byung-Cheon Lee, Min-Su Kim, Inbin Lim, Hee-Jong Woo, Hi-Joon Park, Jan Kehr, and Kwang-Sup Soh. "Catecholamine-producing novel endocrine organ: Bonghan system." *Medical Acupuncture* 20, no. 2 (2008): 97-102.

[https://www.researchgate.net/profile/Jan\\_Kehr/publication/244890795\\_Catecholamine-Producing\\_Novel\\_Endocrine\\_Organ\\_Bonghan\\_System/links/5a97981a0f7e9ba42974ddd4/Catecholamine-Producing-Novel-Endocrine-Organ-Bonghan-System.pdf](https://www.researchgate.net/profile/Jan_Kehr/publication/244890795_Catecholamine-Producing_Novel_Endocrine_Organ_Bonghan_System/links/5a97981a0f7e9ba42974ddd4/Catecholamine-Producing-Novel-Endocrine-Organ-Bonghan-System.pdf)

Kim, Jungdae, Jonghyun Jung, and Michael Potroz. "Summary of Bong-Han Kim's publications." In *The Primo Vascular System*, pp. 7-17. Springer, New York, NY, 2012.

[https://link.springer.com/chapter/10.1007/978-1-4614-0601-3\\_2](https://link.springer.com/chapter/10.1007/978-1-4614-0601-3_2)



Kim, Min-Su, Ju-Young Hong, Su Hong, Byung-Cheon Lee, Chang-Hoon Nam, Hee-Jong Woo, Dae-In Kang, and Kwang-Sup Soh. "Bong-Han corpuscles as possible stem cell niches on the organ-surfaces." *Journal of Pharmacopuncture* 11, no. 1 (2008): 5-12.

<http://www.koreascience.or.kr/article/JAKO200809234354578.page>

Kim, Sungha, Sharon Jiyoung Jung, Sang Yeon Cho, Yoon Kyu Song, Kwang-Sup Soh, and Sungchul Kim. "A Method for the Observation of the Primo Vascular System in the Thoracic Duct of a Rat." *Evidence-Based Complementary and Alternative Medicine* 2013 (2013).

<http://downloads.hindawi.com/journals/ecam/2013/536560.pdf>

Kwon, Byoung S., Chang M. Ha, Sungsook Yu, Byung-Cheon Lee, Jae Y. Ro, and Sunhee Hwang. "Microscopic nodes and ducts inside lymphatics and on the surface of internal organs are rich in granulocytes and secretory granules." *Cytokine* 60, no. 2 (2012): 587-592.

<https://www.sciencedirect.com/science/article/abs/pii/S1043466612005984>

Kwon, Joonhyung, Ku Youn Baik, Byung-Cheon Lee, Kwang-Sup Soh, Nam Joo Lee, and Chi Jung Kang. "Scanning probe microscopy study of microcells from the organ surface Bonghan corpuscle." *Applied Physics Letters* 90, no. 17 (2007): 173903.

<https://aip.scitation.org/doi/abs/10.1063/1.2732183>

Lee, Byung-Cheon, Ku Youn Baik, Hyeon-Min Johng, Tae Jeong Nam, Jawoong Lee, Baeckkyoung Sung, Chunho Choi et al. "Acridine orange staining method to reveal the characteristic features of an intravascular threadlike structure." *The Anatomical Record Part B: The New Anatomist: An Official Publication of the American Association of Anatomists* 278, no. 1 (2004): 27-30.

<https://anatomypubs.onlinelibrary.wiley.com/doi/full/10.1002/ar.b.20018>

Lee, Byung-Cheon, Jung Sun Yoo, Ku Youn Baik, Ki Woo Kim, and Kwang-Sup Soh. "Novel threadlike structures (Bonghan ducts) inside lymphatic vessels of rabbits visualized with a Janus Green B staining method." *The Anatomical Record Part B: The New Anatomist: An Official Publication of the American Association of Anatomists* 286, no. 1 (2005): 1-7.

<https://anatomypubs.onlinelibrary.wiley.com/doi/full/10.1002/ar.b.20076>

Lee, Byung-Cheon, Ku-Youn Baik, Hyeon-Min Johng, Baeck-Kyoung Sung, Kyung-Soon Soh, Dae-In Kang, and Kwang-Sup Soh. "Fluorescent method for observing intravascular Bonghan duct." *Journal of Pharmacopuncture* 8, no. 3 (2005): 5-9.

[http://ocean.kisti.re.kr/download/volume/kpi/DHOCBS/2005/v8n3/DHOCBS\\_2005\\_v8n3\\_5.pdf](http://ocean.kisti.re.kr/download/volume/kpi/DHOCBS/2005/v8n3/DHOCBS_2005_v8n3_5.pdf)

Lee, Byung-Cheon, Jung Sun Yoo, Vyacheslav Ogay, Ki Woo Kim, Harald Dobberstein, Kwang-Sup Soh, and Byung-Soo Chang. "Electron microscopic study of novel threadlike structures on the surfaces of mammalian organs." *Microscopy Research and Technique* 70, no. 1 (2007): 34-43.

<https://onlinelibrary.wiley.com/doi/abs/10.1002/jemt.20383>

Lee, Byung-Cheon, and Kwang-Sup Soh. "Contrast-enhancing optical method to observe a Bonghan duct floating inside a lymph vessel of a rabbit." *Lymphology* 41, no. 4 (2008): 178-185.

<https://journals.uair.arizona.edu/index.php/lymph/article/view/17043>

Lee, Byung-Cheon, Sungkwang Kim, and Kwang-Sup Soh. "Novel anatomic structures in the brain and spinal cord of rabbit that may belong to the Bonghan system of potential acupuncture meridians." *Journal of Acupuncture and Meridian Studies* 1, no. 1 (2008): 29-35.

<https://www.sciencedirect.com/science/article/pii/S2005290109600042>

Lee, Byung-Cheon, Seong-Uk Jhang, Jae-Hong Choi, So-Yeong Lee, Pan-Dong Ryu, and Kwang-Sup Soh. "DiI staining of fine branches of Bonghan ducts on surface of rat abdominal organs." *Journal of Acupuncture and Meridian Studies* 2, no. 4 (2009): 301-305.

<https://www.sciencedirect.com/science/article/pii/S2005290109600728>

Lee, Byung-Cheon, Ki Woo Kim, and Kwang-Sup Soh. "Visualizing the network of Bonghan ducts in the omentum and peritoneum by using Trypan blue." *Journal of Acupuncture and Meridian Studies* 2, no. 1 (2009): 66-70.

<https://www.sciencedirect.com/science/article/pii/S2005290109600170>

Lee, Byung-Cheon, Ki-Hoon Eom, and Kwang-Sup Soh. "Primo-vessels and primo-nodes in rat brain, spine and sciatic nerve." *Journal of acupuncture and meridian studies* 3, no. 2 (2010): 111-115.

<https://www.sciencedirect.com/science/article/pii/S2005290110600209>

Lee, Byung-Cheon, and Kwang-Sup Soh. "Visualization of acupuncture meridians in the hypodermis of rat using trypan blue." *Journal of Acupuncture and Meridian Studies* 3, no. 1 (2010): 49-52.

<https://www.sciencedirect.com/science/article/pii/S2005290110600088>

Lee, Byung-Cheon, Hong Bae Kim, Baeckkyoung Sung, Ki Woo Kim, Jamin Sohn, Boram Son, Byung-Joon Chang, and Kwang-Sup Soh. "Network of endocardial vessels." *Cardiology* 118, no. 1 (2011): 1-7.

<https://www.karger.com/Article/Abstract/323844>

Lee, Byung-Cheon, Hong Bae Kim, Baeckkyoung Sung, Ki Woo Kim, Jamin Sohn, Boram Son, Byung-Joon Chang, and Kwang-Sup Soh. "Structure of the sinus in the primo vessel inside the bovine cardiac chambers." In *The Primo Vascular System*, pp. 57-62. Springer, New York, NY, 2012.

[https://www.researchgate.net/profile/Baeckkyoung\\_Sung/publication/226046695\\_Structure\\_of\\_the\\_Sinus\\_in\\_the\\_Primo\\_Vessel\\_Inside\\_the\\_Bovine\\_Cardiac\\_Chambers/links/0c96052e08a80763a7000000/Structure-of-the-Sinus-in-the-Primo-Vessel-Inside-the-Bovine-Cardiac-Chambers.pdf](https://www.researchgate.net/profile/Baeckkyoung_Sung/publication/226046695_Structure_of_the_Sinus_in_the_Primo_Vessel_Inside_the_Bovine_Cardiac_Chambers/links/0c96052e08a80763a7000000/Structure-of-the-Sinus-in-the-Primo-Vessel-Inside-the-Bovine-Cardiac-Chambers.pdf)

Lee, Changhoon, Seung-Kwon Seol, Byung-Cheon Lee, Young-Kwon Hong, Jung-Ho Je, and Kwang-Sup Soh. "Alcian blue staining method to visualize Bonghan threads inside large caliber lymphatic vessels and X-ray microtomography to reveal their microchannels." *Lymphatic Research and Biology* 4, no. 4 (2006): 181-190.

<https://www.liebertpub.com/doi/abs/10.1089/lrb.2006.4402>

Lee, Ho-Sung, Won-Hee Park, A-Reum Je, Hee-Seok Kweon, and Byung-Cheon Lee. "Evidence for novel structures (primo vessels and primo nodes) floating in the venous sinuses of rat brains." *Neuroscience Letters* 522, no. 2 (2012): 98-102.

<https://www.sciencedirect.com/science/article/abs/pii/S0304394012007768>

Lee, Soo Jae, Byung-Cheon Lee, Chang Hoon Nam, Won-Chul Lee, Seong-Uk Jhang, Hyung Soon Park, and Kwang-Sup Soh. "Proteomic analysis for tissues and liquid from Bonghan ducts on rabbit intestinal surfaces." *Journal of Acupuncture and meridian studies* 1, no. 2 (2008): 97-109.

<https://www.sciencedirect.com/science/article/pii/S2005290109600297>

Lee, Seung-Yoon, Byung-Cheon Lee, Kwang-Sup Soh, and Gil-Ja Jhon. "Development of the putative primo vascular system before the formation of vitelline vessels in chick embryos." In *The Primo Vascular System*, pp. 77-82. Springer, New York, NY, 2012.

Lim, Jaekwan, Jong Hyun Jung, Sungwoo Lee, Zhendong Su, Zhou Qiang, Kwangsup Soh, Jin-Myung Cha, and Jin-Kyu Lee. "Estimating the density of fluorescent nanoparticles in the primo vessels in the fourth ventricle and the spinal cord of a rat." *Journal of Biomedical Optics* 16, no. 11 (2011): 116010.

<https://www.spiedigitallibrary.org/journals/Journal-of-Biomedical-Optics/volume-16/issue-11/116010/Estimating-the-density-of-fluorescent-nanoparticles-in-the-primo-vessels/10.1117/1.3647595.full>

Liu, Jun-Ling, Xiang-Hong Jing, Hong Shi, Shu-Ping Chen, Wei He, Wan-Zhu Bai, and Bing Zhu. "Historical review about research on "Bonghan system" in China." *Evidence-Based Complementary and Alternative Medicine* 2013 (2013).

<http://downloads.hindawi.com/journals/ecam/2013/636081.pdf>

Nam, Min-Ho, Jaekwan Lim, Seung-Hoon Choi, Sungchul Kim, and Kwang-Sup Soh. "A primo vascular system underneath the superior sagittal sinus in the brain of a rabbit." *Journal of acupuncture and meridian studies* 5, no. 5 (2012): 210-217.

<https://www.sciencedirect.com/science/article/pii/S2005290112001070>

Noh, Young-Il, Minsuk Rho, Yeong-Min Yoo, Sharon Jiyeon Jung, and Sang-Suk Lee. "Isolation and morphological features of primo vessels in rabbit lymph vessels." *Journal of Acupuncture and Meridian Studies* 5, no. 5 (2012): 201-205.

<https://www.sciencedirect.com/science/article/pii/S2005290112001057>

Ogay, Vyacheslav, Min Su Kim, Hyo Jun Seok, Cheon Joo Choi, and Kwang-Sup Soh. "Catecholamine-storing cells at acupuncture points of rabbits." *Journal of Acupuncture and Meridian Studies* 1, no. 2 (2008): 83-90.

<https://www.sciencedirect.com/science/article/pii/S2005290109600273>

Ogay, Vyacheslav, Kyung Hee Bae, Ki Woo Kim, and Kwang-Sup Soh. "Comparison of the characteristic features of Bonghan ducts, blood and lymphatic capillaries." *Journal of Acupuncture and Meridian Studies* 2, no. 2 (2009): 107-117.

<https://www.sciencedirect.com/science/article/pii/S200529010960042X>

Ogay, Vyacheslav, and Kwang-Sup Soh. "Identification and characterization of small stem-like cells in the primo vascular system of adult animals." In *The primo vascular system*, pp. 149-155. Springer, New York, NY, 2012.

[https://link.springer.com/chapter/10.1007/978-1-4614-0601-3\\_21](https://link.springer.com/chapter/10.1007/978-1-4614-0601-3_21)

Park, Sang-Hyun, Byung-Cheon Lee, Cheon-Joo Choi, Kwang-Sup Soh, Jae-Hong Choi, Soyeong Lee, and Pandong Ryu. "Bioelectrical study of bonghan corpuscles on organ surfaces in rats." *Journal of Korean Physical Society* 55 (2009): 688.

Shin, Hak-Soo, Hyeon-Min Johng, Byung-Cheon Lee, Sung-Il Cho, Kyung-Soon Soh, Ku-Youn Baik, Jung-Sun Yoo, and Kwang-Sup Soh. "Feulgen reaction study of novel threadlike structures (Bonghan ducts) on the surfaces of mammalian organs." *The Anatomical Record Part B: The New Anatomist: An Official Publication of the American Association of Anatomists* 284, no. 1 (2005): 35-40.

<https://anatomypubs.onlinelibrary.wiley.com/doi/full/10.1002/ar.b.20061>

Shin, H. S., and K. S. Soh. "Electrical method to detect a Bonghan duct inside blood vessels." *New Phys* 45 (2002): 376-378.

Soh, Kwang-Sup. "Current state of research on the primo vascular system." In *The Primo Vascular System*, pp. 25-39. Springer, New York, NY, 2012.

[https://link.springer.com/chapter/10.1007/978-1-4614-0601-3\\_5](https://link.springer.com/chapter/10.1007/978-1-4614-0601-3_5)

Soh, K. S., S. Hong, J. Y. Hong, B. C. Lee, and J. S. Yoo. "Immunohistochemical characterization of intravascular Bonghan duct." *Microcirculation* 13 (2006): 166.

Soh, Kwang-Sup. "Bonghan circulatory system as an extension of acupuncture meridians." *Journal of acupuncture and meridian studies* 2, no. 2 (2009): 93-106.

<https://www.sciencedirect.com/science/article/pii/S2005290109600418>

Soh, Kwang-Sup, Kyung A. Kang, and David K. Harrison, eds. *The Primo Vascular System: Its Role in Cancer and Regeneration*. Springer Science & Business Media, 2011.

<https://books.google.com/books?hl=en&lr=&id=H2vzeIkg-jcC&oi=fnd&pg=PR3&dq=10.%09Soh,+Kwang-Sup,+Kyung+A.+Kang,+and+David+K.+Harrison,+eds.+The+Primo+Vascular+System:+Its+Role+in+Cancer+and+Regeneration.+Springer+Science+%26+Business+Media,+2011.&ots=bcq0gPaMUc&sig=p-ht3OP91dKzm7UQjJuWqOFAgpg#v=onepage&q=10.%09Soh%2C%20Kwang-Sup%2C%20Kyung%20A.%20Kang%2C%20and%20David%20K.%20Harrison%2C%20eds.%20The%20Primo%20Vascular%20System%3A%20Its%20Role%20in%20Cancer%20and%20Regeneration.%20Springer%20Science%20%26%20Business%20Media%2C%202011.&f=false>

Stefanov, Miroslav, and Jungdae Kim. "Primo vascular system as a new morphofunctional integrated system." *Journal of acupuncture and meridian studies* 5, no. 5 (2012): 193-200.

<https://www.sciencedirect.com/science/article/pii/S2005290112001045>

Stefanov, Miroslav, Michael Potroz, Jungdae Kim, Jake Lim, Richard Cha, and Min-Ho Nam. "The primo vascular system as a new anatomical system." *Journal of acupuncture and meridian studies* 6, no. 6 (2013): 331-338.

<https://www.sciencedirect.com/science/article/pii/S2005290113002082>

Sung, Baeckkyoung, Min Su Kim, Byung-Cheon Lee, Jung Sun Yoo, Sang-Hee Lee, Youn-Joong Kim, Ki-Woo Kim, and Kwang-Sup Soh. "Measurement of flow speed in the channels of novel threadlike structures on the surfaces of mammalian organs." *Naturwissenschaften* 95, no. 2 (2008): 117-124.

[https://www.researchgate.net/profile/Baeckkyoung\\_Sung/publication/6125747\\_Measurement\\_of\\_flow\\_speed\\_in\\_the\\_channels\\_of\\_novel\\_threadlike\\_structures\\_on\\_the\\_surfaces\\_of\\_mammalian\\_organs/links/00b7d518f0b3b432e8000000.pdf](https://www.researchgate.net/profile/Baeckkyoung_Sung/publication/6125747_Measurement_of_flow_speed_in_the_channels_of_novel_threadlike_structures_on_the_surfaces_of_mammalian_organs/links/00b7d518f0b3b432e8000000.pdf)

Yoo, Jung Sun, Min Su Kim, Vyacheslav Ogay, and Kwang-Sup Soh. "In vivo visualization of Bonghan ducts inside blood vessels of mice by using an Alcian blue staining method." (2008).

[http://nopr.niscair.res.in/bitstream/123456789/4468/1/IJEB%2046\(5\)%20336-339.pdf?ev=pub\\_ext\\_prw\\_xdl](http://nopr.niscair.res.in/bitstream/123456789/4468/1/IJEB%2046(5)%20336-339.pdf?ev=pub_ext_prw_xdl)

Yoo, Jung Sun, Hong Bae Kim, Nayoun Won, Jiwon Bang, Sungjee Kim, Saeyoung Ahn, Byung-Cheon Lee, and Kwang-Sup Soh. "Evidence for an additional metastatic route: in vivo imaging of cancer cells in the primo-vascular system around tumors and organs." *Molecular Imaging and Biology* 13, no. 3 (2011): 471-480.

[https://www.researchgate.net/profile/Byung-Cheon\\_Lee/publication/44692372\\_Evidence\\_for\\_an\\_Additional\\_Metastatic\\_Route\\_In\\_Vivo\\_Imaging\\_of\\_Cancer\\_Cells\\_in\\_the\\_Primo-Vascular\\_System\\_Around\\_Tumors\\_and\\_Organs/links/0fcfd50fd6b45997ae000000.pdf](https://www.researchgate.net/profile/Byung-Cheon_Lee/publication/44692372_Evidence_for_an_Additional_Metastatic_Route_In_Vivo_Imaging_of_Cancer_Cells_in_the_Primo-Vascular_System_Around_Tumors_and_Organs/links/0fcfd50fd6b45997ae000000.pdf)