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THE HONOURABLE PROFESSOR ISAO KOSHIMA: HISTORICAL CONTRIBUTION FROM MICROSURGERY TO NANOMICROSURGERY

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Abstract

In honour of Professor Isao Koshima's 70th birthday, a short manuscript regarding his main contributions to microsurgery, as well as impact on the surgical specialty in Russian Federation is discussed. The numerous achievements of Professor Koshima are built upon years of experience. Currently, Isao Koshima is the Chief of the International Center for Lymphedema, at Hiroshima University Hospital (Japan). He is known to all as an enthusiastic and extremely talented microsurgeon and a world-known scientist. In 1989, I. Koshima first introduced the epigastric artery perforator flap, and the discovery of the DIEP flap is widely accredited to him. He introduced this flap at the 1st International Course on Perforator Flaps held in Ghent in 1997. Professor Koshima's numerous contributions to the field of microsurgery are truly invaluable. His life and career are respected by all and his guidance is requested daily around the World. I. Koshima's contribution to lymphatic supermicrosurgery is especially prominent, as this field is completely built upon his pronounced expertise. To this day, Isao Koshima offers lectures, training programs and is an active participant of many congresses worldwide, making him one of the most sought teachers in the history of microsurgery.

Keywords: Isao Koshima, short biography, history of microsurgery, history of medicine.

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ИСТОРИЯ МЕДИЦИНЫ

ИСТОРИЧЕСКИЙ ВКЛАД ИСАО КОШИМЫ В РАЗВИТИЕ МИКРОХИРУРГИИ: ОТ МИКРОХИРУРГИИ ДО НАНОХИРУРГИИ

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Аннотация

В честь 70-летия профессора Исао Кошима и с целью осветить его вклад в развитие мировой и отечественной микрохирургии, в данной статье рассматриваются наиболее значимые его достижения и обсуждается их роль в развитии современной микрохирургии. В настоящее время И. Кошима является руководителем Международного центра лимфедемы при университетской больнице г. Хиросимы (Япония). В 1989 г. И. Кошима впервые описал лоскут на основе перфорантного сосуда нижней эпигастральной артерии (DIEP-лоскут), который на сегодняшний день является одним из наиболее часто применяемых лоскутов в реконструктивной микрохирургии. Профессор Кошима участвовал в организации Международного симпозиума по перфораторным лоскутам, впервые проходившего в Генте в 1997 г. Активное развитие микрохирургии на мировом уровне делают И. Кошиму одним из наиболее уважаемых на сегодняшний день хирургов. Вклад профессора Кошима в лимфатическую супермикрохирургию заслуживает отдельного внимания, так как эта область микрохирургии полностью построена на его экспериментальной и клинической деятельности. По сей день Исао Кошима читает лекции, проводит обучающие программы и является активным участником многих конгрессов по всему миру, что делает его одним из самых востребованных преподавателей в истории микрохирургии.

- Ключевые слова:** Исао Кошима, краткая биография, история микрохирургии, история медицины
- Конфликт интересов:** авторы подтверждают отсутствие конфликта интересов, о котором необходимо сообщить.
- Прозрачность финансовой деятельности:** никто из авторов не имеет финансовой заинтересованности в представленных материалах или методах.
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INTRODUCTION

Isao Koshima was born on January 13, 1952 in Okayama, Japan [1]. In 1976 he graduated from Tottori University School of Medicine, after which he worked as a Junior Resident at the Department of General Surgery of Tokyo Women's Medical School until 1977. From 1977 to 1983 he worked as a Senior and Chief Resident at the Department of Plastic and Reconstructive Surgery of Tokyo University. In 1983 he became an Assistant Professor and worked at Tokyo University until 1989. From 1989 to 2000 he worked as an Associate Professor at the Department of Plastic and Reconstructive Surgery of Kawasaki Medical School. At the same time, from 1996 to 1997, he worked as a lecturer at Harvard Medical School. Starting in 2000, he worked as a Professor and Chief of the Plastic and Reconstructive Surgery Department of Okayama University Medical School. From 2004 and currently, Isao Koshima is a Professor and Chief of the Plastic and Reconstructive Surgery Department at the Tokyo Medical University Graduate School of Medicine. From 2009 to 2010 he worked as a Senior consultant at the National University of Singapore. From 2011 to 2013 he worked as a Vice Director of Tokyo University Hospital. From 2012 he is a Visiting Professor at the University of Barcelona. Since 2017 and presently he occupies the prestigious title of Chief of the International Cen-

tre for Lymphedema (ICL) at Hiroshima Medical University Hospital. In 2017 he became a Professor Emeritus of The University Tokyo and President of the World Society Reconstructive Microsurgery (WSRM) [1]. This short introduction in the life of a brilliant microsurgeon, great scientist and highly respected teacher is but a glimpse of the lengthy and prestigious history of I. Koshima's contribution to medicine.

Isao Koshima has been honoured numerous times by many different organizations, including the American Society for Reconstructive Microsurgery, American Society of Aesthetic and Plastic Surgeons (ASAPS), WSRM and other [1–4]. Professor Koshima has published many textbooks, which quickly became standards for training in the fields of lymphedema, microsurgery and reconstructive surgery. Professor Koshima is an active member of many prestigious societies, including World Society for Reconstructive Microsurgery (president from 2017–2019), International Course of Perforator Flaps (founding member), The Japanese Society of Lymphology (executive director), International Society of Lymphology (honorary president), Japanese Society of Reconstructive Microsurgery, Japanese Society of Plastic and Reconstructive Surgery and others. Professor Koshima's reviewer activity and publication activity put him at the very top of his field, unmatched by most.

CONTRIBUTION TO THE FIELD OF MICROSURGERY

Very difficult to measure the exact extent of Isao Koshima's input into the development of microsurgery, but one thing is certain: without his contribution, the field of microsurgery profession would be decades behind where it stands this day. Isao Koshima is not only an outstanding surgeon, who personally made over 3000 free tissue transfers, but he

is also a moving force in the field of scientific research. With over 200 original papers published in English alone, his scientific contribution can already be considered historically valuable. All of these achievements were accompanied by active teaching by Professor Koshima, who continues to participate in numerous live surgery demonstrations in over 20 countries since 1997 [5–10]. The extent of his contributions is shortly summarized in Table.

Isao Koshima's main contributions to medicine

Основной вклад Исао Кошимы в медицину

Year contribution began	Area of focus	Short explanation	References
1983	Nerve graft	I. Koshima introduced the cross-facial nerve graft for muscle protection prior to facial palsy	[10]
1989	Deep inferior epigastric artery perforator (DIEP) flap	The DIEP flap was first described and clinically used by Isao Koshima. Today, the DIEP flap is the golden standard in breast reconstruction	[11–15]
1989	Perforator flaps	Koshima and Soeda were the first surgeons who came up with the term “perforator flap” and introduced several gold standard flaps now commonly used in clinical practice	[13–19]
1990	Supermicrosurgery	Introduction of the supermicrosurgery technique and prime results of applying this technique	[19–24]
1990	Lymphedema pathogenesis discovery: vessel fibrosis	I. Koshima found that lymphedema comes from degeneration of smooth muscle cells within the lymphatic channel. He shows that damaged vessels and surrounding tissues become fibrotic – thicker and stiffer. To prevent degeneration of smooth muscle cell, early stage lymphovenous bypass is necessary	[3, 4]
1990	Lymphovenous anastomosis	I. Koshima was the first to describe and apply the prophylactic lymphaticovenular anastomosis as lymphedema treatment. He developed the so called “one-hand suture technique” and made supermicrosurgery possible. This technique is essential for anastomosing vessels that are less than 0.5 mm in diameter	[6, 17, 18, 25, 26]
1993	Gluteal artery perforator flap (GAP) flap	Isao Koshima first used the GAP flap for sacral decubitus. This surgical procedure involves the reconstruction of sacral sores with the local superior gluteal artery perforator flap	[1, 2]
1993	Anterolateral thigh flap (ALT) flap and chimera flaps	Professor Isao Koshima was the first to describe the versatile application of ALT flaps in head and neck area. Since 2002, the use of this flap has become the method of choice for the reconstruction of head and neck defects in Taiwan and USA, thanks to his description of the anatomical characteristics of perforating vessels, such as intramuscular and intermuscular septum perforating vessels	[11, 12, 22–24]
2006	Penile and urethral reconstruction	Isao Koshima performs free radial forearm osteocutaneous flap with vascular pedicle transfer and chimeric SCIP flap for urethroplasty reconstruction	[4]

As can be seen, Professor Isao Koshima made several revolutionary achievements in the field of plastic and reconstructive surgery. In 1983 he proposed the concept of a nerve graft, in 1989 he introduced the first perforator flap by inventing the DIEP flap, in 1990 he introduced the lymphovenous anastomosis and coined the term “supermicrosurgery”. In 1993, he performed the first ALT flap and chimera combined flaps for head and neck recon-

struction. In 1997 he participated in the establishment of the well-known “International Course on Perforator Flaps” and in 2017 the “International Course on Supermicrosurgery”. Professor Koshima established supermicrosurgery technical standards and helped develop tools for performing vascular anastomosis of vessels under 0.5 mm. Recently, he performed the first nanomicrosurgery procedure: anastomosis of less than 0.3 mm with a 30 micron

needle and introduced the nanomicro-video system [10].

ISAO KOSHIMA'S ROLE INFLUENCE ON RUSSIAN MICROSURGERY: A PERSONAL "THANK YOU"

In Russia, his name is well known in the medical circle. Twice, in 2009 and 2019 he came to Tomsk, to participate in meetings and offer microsurgery training and lectures to students. In 2014 he visited Russia to perform surgery and teach his techniques, which have been used in Russia since then. Professor Koshima is considered a mentor for Russian microsurgery, and his invaluable contribution has provided patients with a new improved standard of care. The techniques he invented and advanced have had a significant impact on patient rehabilitation, improving outcome and quality of life in thousands of patients personally, and tens of thousands through his teachings worldwide.

His contribution to Russian medicine is valued by many prominent specialists, including Professor Igor Reshetov, Academician of the Russian Academy of Sciences, Director of the Institute of Cluster Oncology at Sechenov University, renown oncologist, reconstructive surgeon and microsurgeon. Professor Reshetov states that "...Isao Koshima is a respected and forthgoing microsurgeon, who brought us many new technologies, including neurotization techniques and supermicrosurgery, which we actively translate into our clinical work. His input is dearly valued and highly respected."

Russian-born director of the world-famous Columbia University Microsurgery Research and Training Lab, Dr. Yelena Akelina, honors Professor Koshima's personal contribution to microsurgery, by stating: "I have known Dr. Isao Koshima for more than 17 years and always looked up to him as a visionary with unlimited positive energy. Most of his 'crazy' ideas and visions have become reality... I always admired Dr. Koshima for his amazing abi-

lity to ignite and inspire others while remaining humble about his amazing success in the world of microsurgery. I had the pleasure of seeing different sides of Dr. Koshima: as an elegant traditional samurai, a fun storyteller and amusing dancer... Wishing Professor Koshima all the best wishes in his 70 year young birthday!"

The Director of the Institute of Microsurgery (Tomsk), Professor Vladimir Baytinger states that their "... mutual work began in 2007 and have been meeting in person since 2009." More recently, Professor Baytinger notes that "on October 27, 2019, within the framework of the First Microsurgical Summit in Siberia, held under the patronage of WSRM and EFSM, two demonstration operations were performed at the Institute of Microsurgery by Isao Koshima. One of them was a unique lymphovenous shunt under 3D visualization on a 8 month old child... with special design supermicrosurgery instruments and suture material 13/0 (needle length 1.5 mm, thread thickness 30 microns). For the first time I saw such instruments and suture material... for microvasculature surgery... Professor Isao Koshima is determined to design and apply the 14/0 suture, which I anticipate this to be another revolutionary achievement in medicine!"

Dr. Koshima's contribution to medical sciences and surgical technique is truly valued by all those familiar with microsurgery. Many surgeons utilize his techniques daily, improving patient care and clinical outcome in their practice.

CONCLUSION

A long history of overachievement, scientific discovery and surgical leadership accompany Professor Isao Koshima in his lengthy professional career. His name has cemented itself in the history of microsurgery, reconstructive and plastic surgery. On behalf of the medical community, a heartfelt "thank you" is given to Professor Koshima's continued input, guidance, and leadership.

REFERENCES

1. Web resource <http://www.lymphedema-surgery.org/>
2. Chen W., Jiang B., Zhao J., & Wang P. The superior gluteal artery perforator flap for reconstruction of sacral sores. *Saudi Medical Journal*. 2016;37(10):1140-1143. <https://doi.org/10.15537/smj.2016.10.15682>
3. Seki Y., Kajikawa A. Fundamental and essential techniques for supermicrosurgical lymphaticovenular anastomosis: the art of Isao Koshima's supermicrosurgery. *Plast Aesthet Res*. 2021;8:44. <http://dx.doi.org/10.20517/2347-9264.2021.74>
4. Matsumoto T., Tsumura T., Kishimoto K., Sano H., Doi K., Matsushita M., & Murakami H. Sequential chimeric free deep circumflex iliac artery bone flap and superficial circumflex iliac artery perforator flap from the same site for one-stage reconstructions of severe hand injury: A report of two cases. *JPRAS open*. 2020;26:49-53. <https://doi.org/10.1016/j.jpra.2020.09.005>
5. Koshima I., & Soeda S. Inferior epigastric artery skin flaps without rectus abdominis muscle. *British Journal of Plastic Surgery*. 1989;42(6):645-648. [https://doi.org/10.1016/0007-1226\(89\)90075-1](https://doi.org/10.1016/0007-1226(89)90075-1)
6. Koshima I., Kawada S., Moriguchi T., & Kajiwaru Y. Ultrastructural observations of lymphatic vessels in lymphedema in human extremities. *Plastic and Reconstructive Surgery*. 1996;97(2):397-407. <https://doi.org/10.1097/00006534-199602000-00018>
7. Drobot A., Bez M., Shakra I.A., Merei F., Khatib K., Bickel A., ... & Kakiashvili E. Microsurgery for management

- of primary and secondary lymphedema. *Journal of Vascular Surgery: Venous and Lymphatic Disorders*. 2021;9(1):226-233.
8. Wang M., Li B. Prof. Isao Koshima: start lymphovenous bypass surgery as soon as possible to benefit more patients! *Asvide*. 2018;5:878. Available online: <http://www.asvide.com/article/view/28641>
 9. Hyakusoku H., & Ono S. The History of Propeller Flaps. *Seminars in Plastic Surgery*. 2020;34(3):133-138. <https://doi.org/10.1055/s-0040-1715157>
 10. Koshima I., Narushima M., Mihara M., Yamamoto Y., Iida T., & Uchida G. Prophylactic cross-face nerve flap for muscle protection prior to facial palsy. *Journal of Plastic, Reconstructive & Aesthetic Surgery*. 2011;64(2):185-188. <https://doi.org/10.1016/j.bjps.2010.04.014>
 11. Koshima I., Fukuda H., & Soeda S. Free combined anterolateral thigh flap and vascularized iliac bone graft with double vascular pedicle. *Journal of Reconstructive Microsurgery*. 1989;5(1):55-61. <https://doi.org/10.1055/s-2007-1006851>
 12. Koshima I., Saisho H., Kawada S., Hamanaka T., Umeda N., & Moriguchi T. Flow-through thin latissimus dorsi perforator flap for repair of soft-tissue defects in the legs. *Plastic and Reconstructive Surgery*. 1999;103(5):1483-1490. <https://doi.org/10.1097/00006534-199904050-00021>
 13. Koshima I., Nanba Y., Tsutsui T., Takahashi Y., Urushibara K., Inagawa K., Hamasaki T., & Moriguchi T. Superficial circumflex iliac artery perforator flap for reconstruction of limb defects. *Plastic and Reconstructive Surgery*. 2004;113(1):233-240. <https://doi.org/10.1097/01.PRS.0000095948.03605.20>
 14. Itano H., Andou A., Date H., Koshima I., & Shimizu N. Chest wall reconstruction with perforator flaps after wide full-thickness resection. *The Journal of Thoracic and Cardiovascular Surgery*. 2006;132(1):e13-e14. <https://doi.org/10.1016/j.jtcvs.2006.03.024>
 15. Narushima M., Yamamoto T., Yamamoto Y., Hirai R., Mihara M., & Koshima I. Lateral intercostal artery perforator-based reversed thoracodorsal artery flap for reconstruction of a chronic radiation ulcer of the lower back wall. *Annals of Plastic Surgery*. 2011;67(4):352-356. <https://doi.org/10.1097/SAP.0b013e3182115126>
 16. Narushima M., Yamamoto T., Yamamoto Y., Hirai R., Mihara M., & Koshima I. Lateral intercostal artery perforator-based reversed thoracodorsal artery flap for reconstruction of a chronic radiation ulcer of the lower back wall. *Annals of Plastic Surgery*. 2011;67(4):352-356. <https://doi.org/10.1097/SAP.0b013e3182115126>
 17. Yoshimatsu H., Yamamoto T., Narushima M., Iida T., & Koshima I. Perforator-bridged lymphaticovenular anastomosis. *Journal of Plastic, Reconstructive & Aesthetic Surgery*. 2012;65(10):1438-1439. <https://doi.org/10.1016/j.bjps.2012.04.051>
 18. Mihara M., Hara H., Hayashi Y., Iida T., Araki J., Yamamoto T., Todokoro T., Narushima M., Murai N., & Koshima I. Upper-limb lymphedema treated aesthetically with lymphaticovenous anastomosis using indocyanine green lymphography and noncontact vein visualization. *Journal of Reconstructive Microsurgery*. 2012;28(5):327-332. <https://doi.org/10.1055/s-0032-1311691>
 19. Koshima I., Nanba Y., Tsutsui T., & Takahashi Y. Medial plantar perforator flaps with supermicrosurgery. *Clinics in Plastic Surgery*. 2003;30(3):447-vii. [https://doi.org/10.1016/s0094-1298\(03\)00044-0](https://doi.org/10.1016/s0094-1298(03)00044-0)
 20. Narushima M., Koshima I., Mihara M., Uchida G., & Gonda K. Intravascular stenting (IVaS) for safe and precise supermicrosurgery. *Annals of Plastic Surgery*. 2008;60(1):41-44. <https://doi.org/10.1097/SAP.0b013e3181804bdb38>
 21. Mihara M., Hayashi Y., Iida T., Narushima M., & Koshima I. Instruments for supermicrosurgery in Japan. *Plastic and Reconstructive Surgery*. 2012;129(2):404e-406e. <https://doi.org/10.1097/PRS.0b013e31823af16b>
 22. Koshima I., Hosoda M., Moriguchi T., Hamanaka T., Kawata S., & Hata T. A combined anterolateral thigh flap, anteromedial thigh flap, and vascularized iliac bone graft for a full-thickness defect of the mental region. *Annals of Plastic Surgery*. 1993;31(2):175-180. <https://doi.org/10.1097/00006537-199308000-00018>
 23. Koshima I., Fukuda H., & Soeda S. Free combined anterolateral thigh flap and vascularized iliac bone graft with double vascular pedicle. *Journal of Reconstructive Microsurgery*. 1989;5(1):55-61. <https://doi.org/10.1055/s-2007-1006851>
 24. Koshima I., Soeda S., Yamasaki M., & Kyou J. The free or pedicled anteromedial thigh flap. *Annals of Plastic Surgery*. 1988;21(5):480-485. <https://doi.org/10.1097/00006537-198811000-00015>
 25. Chang D.W., Suami H., & Skoracki R. A prospective analysis of 100 consecutive lymphovenous bypass cases for treatment of extremity lymphedema. *Plastic and Reconstructive Surgery*. 2013;132(5):1305-1314. <https://doi.org/10.1097/PRS.0b013e3182a4d626>
 26. Visconti G., Hayashi A., Salgarello M., Narushima M., Koshima I., & Yamamoto T. Supermicrosurgical T-shaped lymphaticovenular anastomosis for the treatment of peripheral lymphedema: Bypassing lymph fluid maximizing lymphatic collector continuity. *Microsurgery*. 2016;36(8):714-715. <https://doi.org/10.1002/micr.30019>

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