



# A brief history of perforator flaps

Geoffrey G. Hallock

Division of Plastic Surgery, Sacred Heart Hospital, Allentown, Pennsylvania, USA

Correspondence to: Geoffrey G. Hallock, MD. Division of Plastic Surgery, Sacred Heart Hospital, 1230 South Cedar Crest Boulevard, Suite 306, Allentown, Pennsylvania, 18103, USA. Email: gghallock@hotmail.com.

Received: 25 September 2017. Accepted: 12 October 2017; Published: 26 January 2018.

doi: 10.21037/jxym.2018.01.01

View this article at: <http://dx.doi.org/10.21037/jxym.2018.01.01>

*Presented as the Keynote Opening Speech at the 7th China Summit Forum for Perforator Flap, Changsha, September 8, 2017.*

Whereas I have become the epitome of history, it is no wonder I am often called upon to not only reiterate the obvious; but to stress the importance of a knowledge of our history as reconstructive surgeons. This story began when I first met Dr. Juyu Tang, the organizer of this meeting, when I moderated a panel on perforator flaps at the World Society of Reconstructive Microsurgeons in India in 2015. It was a most favorable day, as there was a standing room only audience trying to cram into the room to listen to his lecture. He returned the favor that same year by inviting me to the 11<sup>th</sup> Congress of the Chinese Microsurgical Society, also held in Changsha.

This also jumped started my personal history in China for which I beg your patience during my overview, all an accidental consequence of the many kind gestures given to me at that time. The formality of that grand microsurgical meeting was preceded by a group tour by many of the outstanding faculty to Zhangjiajie, the “Grand Canyon of China”. This venue should be on the “bucket list” as an unbelievable “must see” in everyone’s lifetime. Just like any typical tourist, I have since climbed the Great Wall in Beijing, marched with the terra cotta soldiers in Xian, rode the waves of the Yangtze as they spilled over the largest hydropower plant in the world at the Three Gorges, and even tried to find heaven in Shangri-La.

It would be imprudent here not to include a little of the history of Xiangya Hospital itself which has done so remarkable a job in hosting this meeting (1). Established as Yali Hospital in 1906 with help from Yale University in America, its present name was acquired in 1915 (1). A year before this, Fuqing Yan (1) was the founder and first dean

of the Xiangya Medical College. More important for all of China was his being the founder and first chairman of the Chinese Medical Association, which oversees the Chinese Journal of Plastic Surgery; and proves how everyone’s path will cross each other if only one has travelled far enough. Today Xiangya Hospital has grown to be a tertiary hospital affiliated with Central South University; and home for the training of medical students, residents and fellows in an extraordinary 14 medical and surgical specialties and 16 subspecialties (1).

Now the real reason for my invitation to this perforator flap summit, to give a brief history of the perforator flap itself! This period has been a mere lightning bolt in the context of the history of Earth itself that is some 4.5 billion years old. Homo sapiens for that matter has existed for only some 200,000–300,000 years, adopting a sedentary-agrarian lifestyle we see today just some 12,000 years ago. The first recorded flaps by Sushruta in India date back to 600 B.C. (2). The dark ages followed. It is hard to believe that amputation was the definitive treatment for a leg injury to best save life during the recent American Civil war just 150 years ago.

But what we may call progress began soon afterwards coming from many directions. The German medical student Carl Manchot [1889] for his thesis dissected cadavers to find that the “larger cutaneous arteries appear from the fissure between muscles. Directly above the fascia, they divide into terminal branches and interconnect (3).” But he did not call them perforators. Zongwei Chen [1963] performed the world’s first hand replantation, to begin a career as a great teacher of microsurgery (4). Milton [1970] proved the irrationality of the length: width ratio for random flaps that previously were thought to depend only on the vascularity of the subdermal plexus (5).

Instead, the intrinsic source of that circulation was the more important concept to insure the extent of flap viability, and still is. Orticocchia [1972] (6) and McCraw [1977] (7) demonstrated that musculocutaneous flaps could support large skin territories without the need for a delay procedure, dependent on “perforating muscular vessels (7).” Ponten [1981] reintroduced the fasciocutaneous flap that did not include any muscle whatsoever (8). Cormack and Lamberty suggested 3 different types of fasciocutaneous flaps according to the characteristics and course of the flap source vessel (9). Guofan Yang in a classic reprint [1981] (10) reported the radial forearm flap that when discovered by the Western world was given the appellation the “Chinese flap.” Cormack and Lamberty considered this to be a type C fasciocutaneous flap according to their nomenclature schema (9).

Progress even more rapidly accelerated after Song *et al.*, [1984] presented the anterolateral thigh (ALT) fasciocutaneous flap that they said depended on a septocutaneous vessel arising between the rectus femoris and vastus lateralis muscles (11). This speaker’s first ALT flap experience a few weeks later revealed instead only a solitary musculocutaneous perforator which required a meticulous dissection through the vastus lateralis muscle back to the descending branch of the lateral circumflex femoral source vessel. The flap survived, but that surgeon vowed never to ever do something so difficult again. Little did he know this would some day become for many the “ideal” soft tissue flap (12), and was a “true” perforator flap at that (13)! Soon Nakajima, *et al.* with extraordinary foresight suggested that perforators of the deep fascia could arise in multiple ways (14), each possible to provide the necessary circulation to what would become a perforator flap.

The word “perforator” was specifically used for the first time in the title of a journal article by Kroll and Rosenfield in 1988 (15), where they had used local perforator flaps for posterior midline defects. Koshima, whom many consider the “father” of perforator flaps, in 1989 instead used periumbilical flaps based on deep inferior epigastric artery perforators (16). Hyakusoku [1991] coined the term propeller flap (17), although it wasn’t until later that the hub providing flap circulation was found to be more versatile if relying on a perforator vessel (18). Allen [1994] borrowed Koshima’s original work (16) and became the champion of the DIEP flap for breast reconstruction (19). The next year Angrigiani brought forth the latissimus dorsi musculocutaneous flap without muscle, better known today as the thoracodorsal artery perforator flap (20). Koshima,

once again a superstar in 1998, introduced the concept of supermicrosurgery with an ability to anastomose a perforator-to-perforator, where the latter often became the recipient vessel itself (21). Blondeel, whose continued and extraordinary zealotry had made him “Mr. Perforator Flap,” combined with his similar colleagues to write the first book on just perforator flaps, published in 2006 (22). Saint-Cyr [2010] simplified the name of the area vascularized by a single perforator as its “perforosome” (23). Xin Wang and his co-workers in 2016 hosted the 16<sup>th</sup> International Course on Perforator Flaps in Ningbo, which continues annually as its international faculty spreads the gospel of perforator flaps around the world.

So as one can see, the history of perforator flaps has been very brief, some say still in its infancy and not yet grown up. Slightly more than two decades have elapsed since introduced as a practical entity, a mere grain of sand in the hour glass of the history of the world itself or even flap history. Forgive me for not mentioning every important event and individual in this evolution, as there are many that deserve recognition but time is always restricted. Yet this evolution of perforator flaps will not cease, but will continue as they have now become mainstream (24). All of us privileged to perform reconstructive surgery of any form must be aware of their existence and nuances, and hopefully the rest of this meeting will better achieve that goal. May I now say “Thank you” for your indulging me my memories. Thank you.

## Acknowledgments

*Funding:* None.

## Footnote

*Provenance and Peer Review:* This article was commissioned by the editorial office, *Journal of Xiangya Medicine* for the series “Perforator Flap”. The article did not undergo external peer review.

*Conflicts of Interest:* The author has completed the ICMJE uniform disclosure form (available at <http://dx.doi.org/10.21037/jxym.2018.01.01>). The series “Perforator Flap” was commissioned by the editorial office without any funding or sponsorship. GH served as the unpaid Guest Editor of the series and serves as an unpaid editorial board member of *Journal of Xiangya Medicine*. The author has no other conflicts of interest to declare.

**Ethical Statement:** The author is accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

**Open Access Statement:** This is an Open Access article distributed in accordance with the Creative Commons Attribution-NonCommercial-NoDerivs 4.0 International License (CC BY-NC-ND 4.0), which permits the non-commercial replication and distribution of the article with the strict proviso that no changes or edits are made and the original work is properly cited (including links to both the formal publication through the relevant DOI and the license). See: <https://creativecommons.org/licenses/by-nc-nd/4.0/>.

## References

1. Editorial Office. The History of Xiangya Hospital. J Xiangya Med 2016;1:4.
2. Bhishagratna KK, editor. An English Translation of the Sushruta Samhita, Based on Original Sanskrit Text. Calcutta: Bose, 1907-16.
3. Manchot C. The Cutaneous Arteries of the Human Body. NY: Springer-Verlag, 1983, pp. 136-7.
4. Chen CW, Chien YC, Pao YS. Salvage of the forearm following traumatic amputation: report of a case. Chin Med J 1963;82:633-8.
5. Milton SH. Pedicled skin-flaps: the fallacy of the length: width ratio. Br J Surg 1970;57:502-8.
6. Orticochea M. The Musculo-cutaneous flap method: an immediate and heroic substitute for the method of delay. Br J Plast Surg 1972;25:106-10.
7. McCraw JB, Dibbell DG, Carraway HJ. Clinical definition of independent myocutaneous vascular territories. Plast Reconstr Surg 1977;60:341-52.
8. Ponten B. The Fasciocutaneous flap: its use in soft tissue defects of the lower leg. Br J Plast Surg 1981;34:215-20.
9. Cormack GC, Lamberty BGH. A classification of fasciocutaneous flaps according to their patterns of vascularization. Br J Plast Surg 1984;37:80-7.
10. Yang GF, Chen BQ, Gao YZ, et al. Classic reprint: forearm free skin flap transplantation: a report of 56 cases. Br J Plast Surg 1997;50:162-5.
11. Song YG, Chen GZ, Song YL. The free thigh flap: a new free flap concept based on the septocutaneous artery. Br J Plast Surg 1984;37:149-59.
12. Wei FC, Jain V, Celik N, et al. Have we found an ideal soft-tissue flap? an experience with 672 anterolateral thigh flaps. Plast Reconstr Surg 2002;109:2219-26.
13. Wei FC, Jain V, Suominen S, et al. Confusion among perforator flaps: what is a true perforator flap? Plast Reconstr Surg 2001;107:874-6.
14. Nakajima H, Fujino T, Adachi S. A new concept of vascular supply to the skin and classification of skin flaps according to their vascularization. Ann Plast Surg 1986;16:1-19.
15. Kroll SS, Rosenfield L. Perforator-based flaps for low posterior midline defects. Plast Reconstr Surg 1988;81:561-6.
16. Koshima I, Soeda S. Inferior epigastric artery skin flaps without rectus abdominis muscle. Br J Plast Surg 1989;42:645-8.
17. Hyakusoku H, Yamamoto T, Fumiiri M. The propeller flap method. Br J Plast Surg 1991;44:53-4.
18. Hallock GG. The propeller flap version of the adductor muscle perforator flap for coverage of ischia or trochanteric pressure sores. Ann Plast Surg 2006;56:540-2.
19. Allen RJ, Treece P. Deep inferior epigastric perforator flap for breast reconstruction. Ann Plast Surg 1994;32:32-8.
20. Angrigiani C, Grilli D, Siebert J. Latissimus dorsi musculocutaneous flap without muscle. Plast Reconstr Surg 1995;96:1608-14.
21. Koshima I, Inagawa K, Urushibara K, et al. Paraumbilical perforator flap without deep inferior epigastric vessels. Plast Reconstr Surg 1998;102:1052-7.
22. Blondeel PN, Morris SF, Hallock GG, et al. Editors. Perforator Flaps: Anatomy, Technique, & Clinical Applications. St. Louis: Quality Medical Publishing, 2006.
23. Saint-Cyr M, Wong C, Schaverien M, et al. The perforasome theory: vascular anatomy and clinical applications. Plast Reconstr Surg 2009;124:1529-44.
24. Hallock GG. If based on citation volume, perforator flaps have landed mainstream. Plast Reconstr Surg 2012;130:769e-71e.

doi: 10.21037/jxym.2018.01.01

**Cite this article as:** Hallock GG. A brief history of perforator flaps. J Xiangya Med 2018;3:4.