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Peroneal Artery Perforator Propeller Flap: Perforasome Theory, Perforator Selection, and Tips and Pearls for Increased Safety and Reliability

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I read with interest the paper “The Propeller Flap for Traumatic Distal Lower-Limb Reconstruction Risk Factors, Pitfalls, and Recommendations” (1). I congratulate the authors on the publication of their work. This was a retrospective, multi-center study, not without limitations, yet the authors put together a good work.

While I appreciate the experience presented, I disagree with the statement made against the peroneal artery perforator flap (PAPF) being less reliable compared to the posterior tibial artery perforator flap (PTAPF).

High rate of complications in PAPF group was reported; 8 cases compared to 1 in PTAPF group. However, the selected perforator was closer to injury zone in PAPF group compared to PTAPF cohort. Average distance from the malleolus for the peroneal flap perforator was 10.67 cm vs. 14 cm for the posterior tibial artery flap perforator, range (6-14 vs. 10-22, respectively), and 5/8 complicated PAPF and 1/1 complicated PTAPF were ≥ 10 cm from the malleolus. The significance of this deserves proper investigation before concluding that the peroneal artery perforator propeller flap was unreliable.

Another important element the authors missed is perforasome concept (2). In propeller flaps, the proximal, redundant and healthy tissue is propelled to cover the diseased distal part. For PAPF, this proximal tissue could belong to different perforasomes supplied by musculocutaneous perforators from the peroneal or posterior tibial arteries and septal vessels from the common tibioperoneal trunk (3). Identifying a septal vessel to propel the proximal territory that is supplied by a perforator coming from a different system may yield inferior results compared to the case of the PTAPF, in which perforators commonly share the same perforasome.

A few tips could increase safety and reliability of propeller perforator flaps, here are a few from my vast experience with more than 1000 perforator flaps:

General tips:

- 1-select the perforator furthest from the defect that does the job. This contrasts with the approach advocated by this article in which the perforator closest to the defect, therefore, injury zone was selected.
- 2- Dissect the perforator for 3-4 cm. Mobilize the mother vessel if you must. In this study, only 3 perforators were 3-4 cm in length vs. 1.9 cm average length for all complicated flaps.
- 3- opt for the perforator with the largest comitante vein and the best branching pattern within the subcutaneous tissue.
- 4-Do not sleep on “flap in difficulty”, takeback, convert to free flap, super microsurgery, if you must. Include a second perforator to adequate caliber and length as a lifeboat for super charge.

Peroneal artery perforator flap specific tips:

- 1- When selecting a septal vessel, preserve the posterior crural septum as it acts as medium carrying communicating branches between different perforasomes. Cut the septum only along its attachment with the bone to not disturb the communicating branches. And, if you still need to divide the septum, protect the communicating branches.
- 2- You can further dissect septal and musculoseptal vessels off the periosteum to gain extra length.
- 3- Preoperative CTA could help outlining perforator dominance for optimal design.

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References

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3. Al Deek NF, Kao HK, Wei FC. The Fibula Osteoseptocutaneous Flap: Concise Review, Goal-Oriented Surgical Technique, and Tips and Tricks. *Plast Reconstr Surg*. 2018 Dec;142(6):913e-923e.

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Article Author Response

31 March 2020

Article Author(s) to Letter Writer(s)

Reply to: Peroneal Artery Perforator Propeller Flap: Perforasome Theory, Perforator Selection, and Tips and Pearls for Increased Safety and Reliability

Radu Olariu, MD

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Dear Dr. Al Deek

Thank you very much for your comments. We would however like to draw the attention to a few facts:

Firstly, this study was not a multicenter study, as you imply. It was a single-center study with all the cases operated on by the senior author (RO). It is also important to note that the etiology of these lower leg defects was traumatic in origin.

Secondly, the affirmation that the selected perforator was closer to the injury zone in the PAPF is not supported by or stated in the article. The perforator was chosen, as already mentioned in the article, based not only on the proximity to the defect, but also on the clinical judgment of size and the presence of visible pulsations. Moreover, the location of the traumatic defects was variable and therefore no conclusion can be drawn regarding the position of the perforator in relationship with the defect.

Thirdly, while we are familiar with the perforasome theory (1), we consider the discussion incomplete without citing Ian Taylor and his study on choke vessels (2). While the distal part of the flap could have represented a perforasome pertaining to a different supplying vessel, the presence of choke vessels and the changes that they undergo are believed to be able to supply the adjacent angiosome.

While we appreciate the tips and tricks in the free fibula flap raising technique, it is not quite relevant to our propeller flap study. We are looking forward to reading the author's publication of his large

experience with more than 1000 propeller flaps in the future.

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1. Saint-Cyr M, Wong C, Schaverien M, Mojallal A, Rohrich RJ. The perforasome theory: Vascular anatomy and clinical implications. *Plast Reconstr Surg*. 2009;124(5):1529-1544. doi:10.1097/PRS.0b013e3181b98a6c
2. Taylor GI, Corlett RJ, Caddy CM, Zelt RG. An anatomic review of the delay phenomenon: II. Clinical applications. *Plast Reconstr Surg*. 1992;89(3):408-416. doi:10.1097/00006534-199203000-00002

E-Letter Writer Response

3 April 2020

Letter Writer(s) to Article Author(s)

Dear Dr. Olariu

Thank you very much for your reply. I appreciate correcting me on the location of the study and who did it. Seeing a few surgeons from Romania as authors lead me into the assumption that this was multi-center study, but it was not as you kindly pointed out.

With regards to the points you drew my attention to, I still have a few more comments, I hope you can bear with me:

First, perforator location and high complications rate in PAPF. I quote “A possible flap outline, based on the perforator closest to the defect, was also marked on the skin. The width of the flap was designed to match the defect diameter, and the flap length was designed to ensure adequate reach based on the perforator located closest to the defect” (1). Then, it was stated that, I quote, “After perforator dissection, the tourniquet was released and the flap’s pedicle perforator was chosen on the basis of the clinical judgment of size, visible pulsations, and proximity to the defect” (1). Then, I quote, “the final perforator choice was made clinically on the basis of the surgeon’s experience and judgment” (1) One point is were you able to explore more than one perforator in all your cases, so that you can select what you thought an optimal one? Ideally, we should, but was that done in actuality?

The second point is to plan to use the closest perforator then to select your perforator based on judgment and experience, with high complications rate in PAPF compared to that in the PTAP leave readers with only a few choices: To accept that the PAPF is problematic in this group of patients, or to question the

clinical judgment and/or technique. I could not accept that the flap was inferior, and I never question my colleagues' experiences. That is why I promptly analyzed the distance your selected vessel was from the respected malleolus, based on your own published measures. And, it was closer to the malleolus in PAPF. This is for your reference: Average distance from the malleolus for the peroneal flap perforator was 10.67 cm vs. 14 cm for the posterior tibial artery flap perforator, range (6-14 vs. 10-22, respectively), and 5/8 complicated PAPF and 1/1 complicated PTAPF were 10 cm from the malleolus. Yes, the defect could have been anywhere as you said, but it is anywhere between the malleolus and the perforator, so when your perforator is closer to the malleolus, I believe it is closer to the defect. This section is to bring light to a possibly important element not fully investigated. Investigating this, and maybe further analyzing the actual distance from trauma zone, and whether the perforator belonged to the same compartment or angiosome affected by trauma could yield different findings.

Second, perforasome and angiosome. The perofrasome theory can be seen as true example of “standing on the shoulders of giants”, in this case it is the angiosome work. However, perforasome remains unique and distinguished from the angiosome (2). That is why I do not think relying on the angiosome concept, stated in your paper in a few sections, was useful. My comments were spot on, I quote you “While the distal part of the flap could have represented a perforasome pertaining to a different supplying vessel, the presence of choke vessels and the changes that they undergo are believed to be able to supply the adjacent angiosome” (1). I read this and I thought do not you think that if those choke vessels were effective, you would have had different results?

I really am trying to bring fresh different insights as I firmly believe the flap is reliable with certain tweaks.

Third, understanding the anatomy of the fibula allows better application of its propeller flaps, this remains useful to readers, I hope (3).

My experience is more than 1000 perforator flaps through the body, and not only propeller flaps. It is confirmed and verifiable. And, yes, I would like to publish it once I have the time. Maybe when I am near retirement. When I do, I would like to share it with you and many others; some may benefit from my understanding to perforator flaps, and my evolution as a perforator flap surgeon. Until then, I will continue to debate, argue and engage in scientific constructive discussion on a topic I deal with almost every day, know very well and passionate about.

With respect, wishing you all safety in these uncertain times.

References

1. Lese I, Grobbelaar AO, Sabau D, Georgescu AV, Constantinescu MA, Olariu R. The Propeller Flap for Traumatic Distal Lower-Limb Reconstruction: Risk Factors, Pitfalls, and Recommendations. *J Bone Joint Surg Am*. 2019 Dec 4.
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