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## Digital artery perforator (DAP) flaps: Modifications for fingertip and finger stump reconstruction<sup>☆</sup>

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**Summary** Various fingertip reconstructions have been reported for situations where microsurgical finger replantation is impossible. One method is the digital artery perforator (DAP) flap. Herein we report 13 DAP flaps for fingertip and finger stump reconstruction following traumatic finger amputations, highlighting modifications to the originally described DAP flap.

**Methods:** From October 1998 to December 2007, a total of 13 fingers (11 patients) underwent fingertip and finger stump reconstruction with modified DAP flaps following traumatic finger amputations. We performed six adipocutaneous flaps, three adipose-only flaps, two supercharged flaps and two extended flaps. Flap size ranged from 1.44 to 8 cm<sup>2</sup> (average 3.25 cm<sup>2</sup>).

**Results:** All flaps survived completely with the exception of partial skin necrosis in two cases. One of these cases required debridement and skin grafting. Our initial three cases used donor-site skin grafting. The donor site was closed primarily in the 10 subsequent cases. No patients showed postoperative hypersensitivity of repaired fingertips. Semmes–Weinstein (SW) test result for flaps including a digital nerve branch did not differ from those without (average 4.07 vs. 3.92).  
**Conclusions:** Modified DAP flaps allow for preservation of digital length, volume and finger function. They can be raised as adiposal-only flaps or extended flaps and supercharged through perforator-to-perforator anastomoses. The donor defect on the lateral pulp can be closed primarily or by skin grafting. For traumatic fingertip and finger stump reconstructions, DAP flaps deliver consistent aesthetic and functional results.

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In terms of both functionality and aesthetics, fingers are very important organs. Finger and fingertip amputations are consequently damaging to patients not only physically, but also psychologically. Replantation is the best treatment in terms of restoring fingertip function, preserving the fingernail and obtaining an optimal cosmetic result. However, in many situations, fingertip replantations can be difficult to perform.

Various finger reconstructions have been reported for situations where replantation is impossible.<sup>1–7</sup> As the name suggests, digital artery perforator (DAP) flaps are perforator flaps based off the digital arteries. The concept of DAP flaps arose from the observation that many arterial branches from the digital artery originate in the lateral aspect of the finger. These branches perforate the thin fascia and adiposal tissue in the fingertip, terminating in multiple arterioles in the subdermal layer. (Figure 1A).<sup>8,9</sup> Koshima et al. originally reported the utility of DAP flaps for fingertip reconstruction.<sup>1</sup> Herein we report our 10-year experience with the use of DAP flaps for finger reconstruction. This experience highlights modifications to the originally described DAP flap, including adiposal-only/extended DAP flaps and supercharged flaps.

## Materials and methods

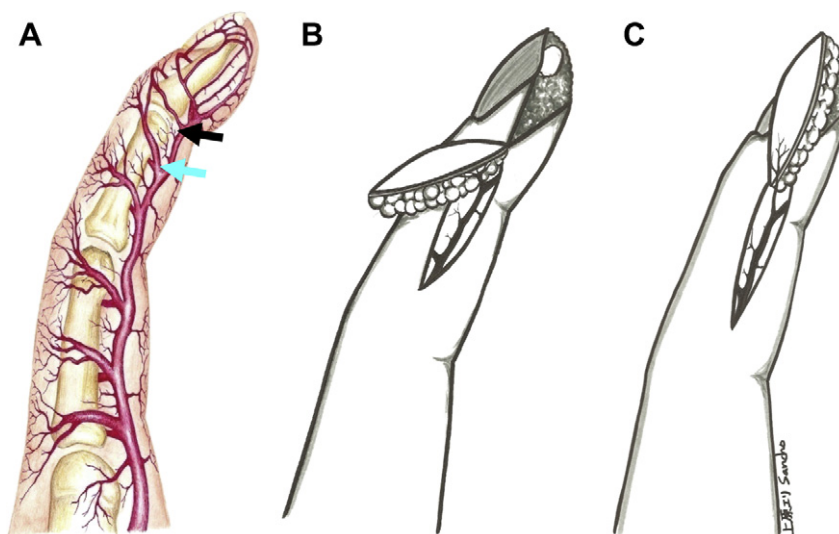
The design of the digital artery perforator flap is outlined on the radial or ulnar aspect of the fingers, because it is easy to detect the perforators as they branch off the digital artery at these locations, and because harvest at this site minimises the operational scar. The designed flap is elevated superficial to the digital neurovascular bundle (Figure 1B). At the side of the flap most proximal to the defect, the DAP closest to the defect is preserved as a pedicle vessel. Other perforators are transected after marking the ends of these perforators with pinpoint injection of pyoktanin blue. The perforator-based island flap is then rotated 180° to cover the defect and the skin is closed (Figure 1C).

When it is difficult to prevent direct compression of the pedicle with primary donor-site closure, artificial dermal skin is used to cover the donor site. The donor site can then be closed gradually through secondary intention once the flap has become established at the recipient site. Adiposal-only DAP flaps can be elevated in cases where adequate skin coverage can be achieved with skin harvested from the crushed fingertip. This allows for increased flap surface area beyond the roughly 1 cm width restriction for the traditional DAP flap. In cases where vascular flow is unstable, the flap can be supercharged through perforator-to-perforator anastomoses. Use of the intravascular stenting technique (IVaS) greatly facilitates anastomoses of these small vessels.<sup>10</sup> This technique uses a nylon as the guide for checking the vessel's lumen.

From October 1998 to December 2007, a total of 13 fingers (in 11 patients) underwent fingertip reconstruction with DAP flaps, following traumatic fingertip amputations. Patient age ranged from 4 to 74 years (average 39) with a male predominance (M:F:: 9:2). One thumb, two index, five middle, two ring and three little finger fingertips were reconstructed. We performed six adipocutaneous flaps, three adipose-only flaps, two supercharged flaps and two extended flaps. Flap size ranged from 1.44 to 8 cm<sup>2</sup> (average 3.25 cm<sup>2</sup>). Flaps were checked by a pinprick or refilling testing to immediately confirm adequate blood supply once the flap was inset.

## Results

All flaps survived completely with the exception of partial skin necrosis in two cases. One of these two cases required debridement and skin grafting. Our initial three cases used donor-site skin grafting. The donor site was closed primarily with sutures in all other cases. Supercharging of flaps through perforator-to-perforator anastomoses was undertaken in two cases. The sizes of supercharged vessels were 0.3 mm and 0.2 mm. The nylon sizes were 12/0 and 11/0. Three flaps included a digital nerve branch. Two patients



**Figure 1** A: Anatomy of the digital artery and digital artery perforators. Blue arrow: Digital artery perforator suitable for use as a DAP flap pedicle. Black arrow: narrow arteriole arising from the digital artery. B, C: Digital Artery Perforator (DAP) flap design: The design of the digital artery perforator flap is outlined on the radial or ulnar aspect of the fingers. B: The designed flap is elevated superficial to the digital neurovascular bundle. C: The perforator-based island flap is then rotated 180 degrees to cover the defect, and the donor site is closed.

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