Two Cases of the Vascular Territory of a Single-pedicled Deep Inferior Epigastric Perforator Flap with a Vertical Midline Abdominal Scar

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Summary: The deep inferior epigastric perforator (DIEP) flap is becoming the gold standard for breast reconstruction using autologous tissue. If there are scars in the abdomen from previous surgery, it is necessary to judge the indication for using this flap carefully. Particularly in cases with vertical midline scars, the blood flow supply to the zone II can be compromised. Even when patients have a median abdominal scar, it has been reported that the blood flow can extend beyond the scar and reach several centimeters to about half of zone II. We performed breast reconstruction using DIEP flaps for 2 patients with vertical midline scars in the lower abdomen. Indocyanine green angiography was conducted intraoperatively to confirm the vascular territory with a single pedicle before cutting off the flap. One patient showed fluorescence contrast on the contralateral side across the midline scar. However, the fluorescence contrast was absent across the midline scar in the other patient. Based on this result, we investigated the possible vascular territory of a single pedicled DIEP flap in patients with vertical midline abdominal scars. We suggest that successful blood supply to zone II of a single-pediced DIEP flap in a patient with a vertical midline abdominal scar is related to the location of the perforator and the property of the tissue in the midline near the perforator. However, because it is difficult to predict the vascular territory of a single pedicle before surgery, intraoperative evaluation using such techniques such as indocyanine green fluorescence imaging is important. (Plast Reconstr Surg Glob Open 2020;8:e2684; doi: 10.1097/GOX.0000000000002684; Published online 11 March 2020.)

INTRODUCTION

The deep inferior epigastric perforator (DIEP) flap has become the gold standard of autologous breast reconstruction. However, if there are scars in the abdomen from previous surgery, the perfusion pattern in the flap becomes irregular, thereby affecting its survival.1–5 Particularly in cases with vertical midline scars, problems can arise as to whether the blood supply to the contralateral side across the midline scar can be secured. Previous studies have reported that blood flow to the contralateral side across a scar can be somewhat secured, even in cases of vertical midline scars.2,3 We performed breast reconstruction using DIEP flaps for 2 patients with vertical midline scars in the lower abdomen. Indocyanine green (ICG) angiography was conducted intraoperatively for evaluating the blood perfusion area of a single-pedicled DIEP flap. One patient showed fluorescence contrast on the contralateral side across the midline scar. However, the fluorescence contrast was absent across the midline scar in the other patient. Based on this result, we investigated the possible vascular territory of a single pedicled DIEP flap in patients with vertical midline abdominal scars. We suggest that successful blood supply to zone II of a single-pediced DIEP flap in a patient with a vertical midline abdominal scar is related to the location of the perforator and the property of the tissue in the midline near the perforator. However, because it is difficult to predict the vascular territory of a single pedicle before surgery, intraoperative evaluation using such techniques such as indocyanine green fluorescence imaging is important.

CASE PRESENTATIONS

Case 1

We performed breast reconstruction using a DIEP flap on a 50-year-old woman who had undergone a cesarean...
section 10 years previously. Preoperative computed tomographic angiography (CTA) showed an effective medial row perforator at the lower right abdominal quadrant near the umbilicus. Intraoperative ICG angiography was conducted with single pedicled and fluorescence contrast was observed up to half of zone II across the midline scar (Fig. 1). The flap was transferred and all survived.

**Case 2**

We performed breast reconstruction using a DIEP flap on a 47-year-old woman who had undergone resection of a benign ovarian tumor 18 years previously. Preoperative CTA showed an effective medial row perforator at the upper right abdominal quadrant near the umbilicus. We assumed that contralateral blood flow could be somewhat secured even if there was a vertical abdominal scar. However, intraoperative ICG angiography was conducted with single pedicled, and fluorescence contrast was absent across the midline scar (Fig. 2). Because the flap volume was clearly insufficient for transfer, a double-pedicled DIEP flap was constructed. This flap all survived and the scar remained in the middle of the skin island of the flap.

**DISCUSSION**

The DIEP flap is becoming the gold standard for breast reconstruction using autologous tissue. However, for patients who have an abdominal scar from past surgery, it is necessary to judge the indication for using an abdominal flap carefully. Various measures and complications have been reported, depending on the location and nature of the scar.1–5

In patients with a lower abdominal midline scar, the blood flow supply to the contralateral zone II can be compromised. Therefore, measures such as a hemiflap, a bipedicled flap, or supercharging on the other side can be considered.6–8 Laporta et al2 proposed a method for making a hemiflap and subsequent fat transplantation.

It has been reported that the blood flow in such cases can extend beyond the scar and reach several centimeters to about half of zone II.2,3 However, no clear evidence was given, and their report did not show information such as whether the flap was divided completely or incompletely by scar tissue, the number of years after surgery, or the results of preoperative examinations.

Blood flow to the contralateral zone II is secured by indirect linking vessels mainly through the subdermal plexus and by direct linking vessels between perforators. It is considered that linking to zone II is stronger for the medial row of perforators.5,6 In patients with vertical midline scars, if the extent of the normal tissue without scarring in the vertical direction is maintained to some extent in the flap, indirect linking vessels can be retained at the same site, and the direct linking vessels can also remain.

ICG fluorescence imaging is often used to confirm blood flow in flaps intraoperatively, and its usefulness has been reported in many cases.9,10 We performed intraoperative ICG angiography to confirm the vascular territory with a single pedicle. In case 1, the perforator was in the medial row and about 50% of the length of normal tissue without scar in the flap was maintained, and the perforator was located in the vicinity. Preoperative CTA failed to confirm any clear direct linking vessel at the normal site. The ICG examination showed fluorescence imaging on the contralateral side beyond the scar. In case 2, the perforator was in the medial row and the amount of normal tissue was maintained, but the flap contained the umbilical part and was located near the perforator. No obvious direct linking vessel could be confirmed with preoperative CTA, and fluorescence imaging was interrupted at the scar (see figure, Supplemental Digital Content 1, which displays the location of the remaining indirect linking vessel in the flap. Left: case 1. Green arrows indicate normal tissue occupying about 50% of the flap length. Blood flow to zone II might have been maintained thanks to linking in this region. Right: case 2. Green arrows indicate normal tissue except for the umbilical part. Because this flap site is short, the indirect linking vessel might be insufficient, so blood flow to zone II may be interrupted in the scar, [http://links.lww.com/PRSGO/B322](http://links.lww.com/PRSGO/B322).

Based on these findings, we suggest that successful blood supply to zone II of a single-pedicled DIEP flap in a patient with a vertical midline abdominal scar is related to the location of the perforator and the property of the tissue in the midline near the perforator. Even if there is a scar, depending on the position of the perforator and the length of the scar in the flap, some blood supply to zone II can be expected. For patients with vertical midline scarring in the vertical direction is maintained to some extent in the flap, indirect linking vessels can be retained at the same site, and the direct linking vessels can also remain.

**Fig. 1.** Case 1. A, Black lines indicate the flap design; red-dotted lines indicate the abdominal scar; a yellow star indicates the location of the perforator; blue-dotted lines indicate the transferred range of the flap. B, Intraoperative indocyanine green fluorescence imaging; red-dotted lines indicate the location of the scar; and the green-dotted line indicates the range of fluorescence imaging of blood flow crossing the midline scar.
abdominal scars, the above points might also be helpful when considering the volumes of flaps that can be used.

It is difficult to predict the blood supply range of a single pedicle accurately before surgery. It is necessary to examine the vascular territory during surgery with techniques such as ICG angiography and to determine the site to be transferred and the treatment of the contralateral pedicle.

**CONCLUSIONS**

In general, blood flow to the contralateral side may be secured somewhat by angiogenesis or via normal tissue even if the abdomen has a vertical midline scar. However, as in case 2 herein, blood flow can be interrupted at midline scars. It is difficult to examine the hemodynamics of a single-pedicled DIEP flap preoperatively and predict the volumes of flaps that can be used in patients with vertical midline abdominal scars. Intraoperative evaluation using techniques such as ICG fluorescence imaging is important.

**Fig. 2.** Case 2. A, Black lines indicate the flap design; red-dotted lines indicate the abdominal scar; a yellow star indicates the location of the perforator. B, Intraoperative indocyanine green fluorescence imaging. Red-dotted lines indicate the location of the scar. The green-dotted line indicates the range of fluorescence imaging of blood flow, which was completely interrupted at the scar.

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