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Studying the blood pressures of antegrade and retrograde internal mammary vessels: Do they really work as recipient vessels?

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Summary Background: The proximal ends of internal mammary (IM) vessels are now the most common recipient vessels for breast reconstruction. On the other hand, bilateral deep inferior epigastric artery perforator (DIEP) flaps are often needed according to the territory and the volume required for reconstruction. The usefulness of retrograde IM vessels as second recipients has recently been reported, but there are very few quantitative studies on the hydrodynamics of the retrograde IM vessels. Because the flow is dependent on the pressure differential, the blood pressures of the antegrade IM artery (AIMA), antegrade IM vein (AIMV), retrograde IM artery (RIMA), retrograde IM vein (RIMV), and recirculated intraflap vein (FV) were investigated to solve this question and to confirm the reliability and usefulness of the retrograde IM vessels.

Methods: Ten free flap breast reconstructions were included in this study. The IM vessels were exposed, and the pressures were measured. After recirculation, the FV pressures were measured when the flap was not ischemic or congestive. Systemic blood pressure was also recorded during the whole measurement period.

Results: The AIMA and RIMA pressures were 70.4 ± 8.2 mmHg and 54.0 ± 8.6 mmHg ($p = 0.000003$), respectively, while the systemic pressure was 65.1 ± 10.0 mmHg. The AIMV pressure was always smaller than the RIMV pressure; the mean AIMV pressure was 5.3 ± 1.6 mmHg. In addition, the FV pressure was greater ($p = 0.03$) than the RIMV pressure (17.7 ± 9.9 mmHg), while the RIMV pressure was 8.7 ± 2.0 mmHg.

Conclusions: Both the RIMA and RIMV are useful and reliable as second recipients for bipedicle free flap transfers. This is a great benefit because it would provide two recipients in one

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surgical site and would be especially useful in thin patients or patients with previous abdominal scars requiring double pedicled DIEP flaps.

Level of evidence: Therapeutic Study, Level IV.

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Introduction

Internal mammary (IM) vessels have become the standard recipient vessels for breast reconstruction in the last decades, especially with the deep inferior epigastric artery perforator (DIEP) flap. In many cases, a bilateral pedicle is required for a single breast reconstruction, especially in thin patients, patients with large breasts who prefer to avoid contralateral reduction mammoplasty, or patients with previous abdominal scars.^{1–3} In such cases, it has been common to use an intraflap anastomosis or thoracodorsal vessels to provide circulation to both pedicles. Recently, the usefulness of the retrograde IM vessels as recipient vessels has been recognized clinically.^{3–6} The advantages of this approach are that it does not require another recipient site dissection, it is not influenced by irradiation or axial clearance, and the double pedicle anastomosis has a lower risk than the intraflap anastomosis. As there have been few quantitative studies, the blood pressures of the retrograde IM vessels were investigated and compared with those of antegrade IM vessels because the flow is dependent on the pressure differential and resistance of the vessels. The pressure of the vein branch of the recirculated flap was also studied to verify the credibility of the retrograde IM vessels as recipient vessels.

Patients and methods

During 2012, 10 patients underwent breast reconstruction (primary reconstruction in eight cases and secondary reconstruction in two cases) after studying the blood pressures of the IM vessels as recipients. The patients' ages ranged from 42 to 57 years, with a mean age of 49.7 years. The study was conducted in keeping with the principles outlined in the Declaration of Helsinki.

Description of investigation of vessel blood pressures

The patients were fully informed concerning reasons and the technique used in this study. After mastectomies were performed by the breast surgeons or a subcutaneous pocket was created for secondary reconstructions, the third costal cartilage was removed to access the vessels in the usual fashion. An intravenous catheter (24G; Terumo Co., Tokyo, Japan) was inserted directly into the IM arteries and veins (Figure 1). The vessels were then clamped using hemostatic clips (BEAR Medic Co., Chiba, Japan) distal to the catheter to measure the pressures of the antegrade IM vessels and proximal to the catheter to measure the pressures of the retrograde IM vessels. After microanastomosis, blood

pressure of either the deep inferior epigastric vein (DIEV) or superficial inferior epigastric vein (SIEV) was also measured to determine the intraflap vein (FV) pressure. The radial artery (RA) pressure was also measured as a reflection of the systemic blood pressure in the same manner.

Pressure measurement

A 24-gauge catheter was inserted into the target vessel and then connected to a fluid pressure monitoring system (Lifescope: Nihon Koden, Tokyo, Japan). The line solution of the catheter contained heparin (10 units/ml) in 0.9% sodium chloride. Zero calibrations were taken at the cardiac level. The first author (YK) performed this measurement in all cases. The mean blood pressure was recorded and analyzed. Paired t-test was performed, and p value < 0.05% was considered significant.

Results

The mean pressure of the AIMA was 70.4 ± 8.2 mmHg, 108% of the systemic blood pressure. The mean pressure of the RIMA was 54.0 ± 8.6 mmHg, 77% of the AIMA (Figure 2). p values according to paired t test were 0.0000336 between the AIMA and RIMA, 0.0164 between the RA and AIMA, and 0.000578 between the RA and RIMA.

The RIMV pressure was relatively constant within the range of 6–12 mmHg (8.7 ± 2.0 mmHg), which was smaller ($p = 0.03$) than the intraflap vein pressure (17.7 ± 9.9 mmHg) (Figure 3). p value according to paired t test was 0.0000542 between the AIMV and RIMV, and 0.0044 between the FV and AIMV.

During this study, double pedicled DIEP flap was used in two patients. The reason for the bipedicle was complete midline cesarean section scar in one patient. In the other patient, bipedicle flap was used because the powerful perforator was based on the lateral row while the total flap was needed for enough reconstruction. The retrograde IMAV was used in these two patients, and another patient had one anastomosis with the retrograde IMV to make two venous anastomosis while there were only one IMV. There was no additional anastomosis needed to other recipient vessel like the thoracodorsal or cephalic vein for any reason. There was no complication except the occurrence of one hematoma.

Discussion

The DIEP flap is currently one of the best options for autologous breast reconstruction. On the other hand, there are cases when bilateral flaps are needed, such as thin

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