

Yuichi Hirase

Practical Techniques in Flap Surgery

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I have received support from many people, but above all, Dr. Harry J. Buncke and Dr. Tadao Kojima, without whom I certainly would not be where I am now. I dedicate this book to these two great masters.

Preface

This book is the English version of *Yasashii Hiben* (Practical and Gentle Techniques in Flap Surgery) published in Japanese by Kokuseido Co., Ltd. in 2009. It was created in response to strong calls for the release of an English version after the Japanese version was published.

The present volume differs from conventional books on flap surgery in a number of respects. First, it explains techniques not by type of flap surgery but by the area to be reconstructed. In addition, it presents applicable flap surgery methods and explains each method in an easy-to-understand manner by using photographs, following the steps of the surgical procedure. Furthermore, it indicates the difficulty level of each surgical method in order to allow selection of the one that suits the surgeon's skills. Each chapter is followed by "Tips" that provide useful information on treatment and a "Column" on the author's ideas and experiences. The author hopes that the book will serve as a helpful reference for readers.

The author would like to express his deep gratitude to Ms. Misuzu Yoshikawa, Erklären Inc., for her enormous efforts in bringing this English version to press.

Chiyoda-ku, Tokyo, Japan
Autumn 2015

Yuichi Hirase

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Basic Principles

Exposure of blood vessels or nerves of the medial elbow, or exposure of the bone of the lateral elbow must be covered using a skin flap. Although a number of either normal flow or reverse flow vascularized flaps can be created in the elbow region, in many cases blood vessel damage is also present, and there are often restrictions on the size of the flap, so focusing only on the upper arm can make surgery more difficult. In spite of large dissection, a vascularized latissimus dorsi flap is stable and practical.

With skin graft using negative pressure wound therapy, because the elbow is not required to be fixed in place, there is less chance of contracture occurring, and even when graft conditions are poor, there is a high ratio of the graft taking, making it extremely practical.

Selectable Flaps and Surgical Procedures

Pedicled latissimus dorsi musculocutaneous flap • Skin graft pressure method using negative pressure wound therapy



The difficulty level of each surgical procedure is shown subsequent to the procedure title (e.g., Level of Difficulty: 2). The levels range from 1 to 5, with level 1 indicating a preliminary level and level 5 indicating a very advanced level.

Pediced Latissimus Dorsi Musculocutaneous Flap (Level of Difficulty: 3)

Information

Vascular pedicle thoracodorsal blood vessel (the circumflex scapular artery is ligated and detachment continued up to the subscapular blood vessels)

Size (muscle flap) width of 40 cm and length of 40 cm; if thoracolumbar fascia is included, it is possible to harvest the entire 60 cm length

Advantage Good circulation, vascular pedicle is large and long, technique is comparatively easy. Can freely design skin on muscle flap

Disadvantage Large dissection area, and large amount of blood loss. Cases with a thick layer of fat over the latissimus dorsi muscle causes bulkiness preventing it from being used as a musculocutaneous flap, and therefore a skin graft is required (1.5 times mesh skin graft)

Caution The muscle head is also cut, creating a complete muscle island flap. Do not use an electrical scalpel after cutting the muscle ends. The space following removal of the latissimus dorsi muscle can cause a painful seroma, so several continuous suction drains should be put in place.



Operation Procedures

Fig. 1.1 (a, b) Procedure 1: Restriction in range of movement in the elbow joint due to advanced scar contraction of medial elbow. Scar resection expects skin defect on medial elbow due to elbow extension



Fig. 1.2 Procedure 2: After resecting the scar and conducting joint mobilization surgery it was possible to extend the elbow, however a skin defect and exposure of the medial nerves and blood vessels were present



Fig. 1.3 Procedure 3: A latissimus dorsi musculocutaneous flap is elevated. The distal end of the muscle is cut, and a complete island musculocutaneous flap with only a neurovascular pedicle is created

Note The vascular intima can be damaged if an electric scalpel is used after creation of the island musculocutaneous flap by cutting the proximal end of the muscle, so care is required. If a skin flap is required, it is possible to elevate a latissimus dorsi muscle flap that has an island the same size as the distance from the axillary fossa to the skin defect of the elbow, however it is often bulky.

Refer to Section of “Reconstruction of Achilles tendon area/Free latissimus dorsi musculocutaneous flap (serratus anterior musculocutaneous flap)” in Chap. 17

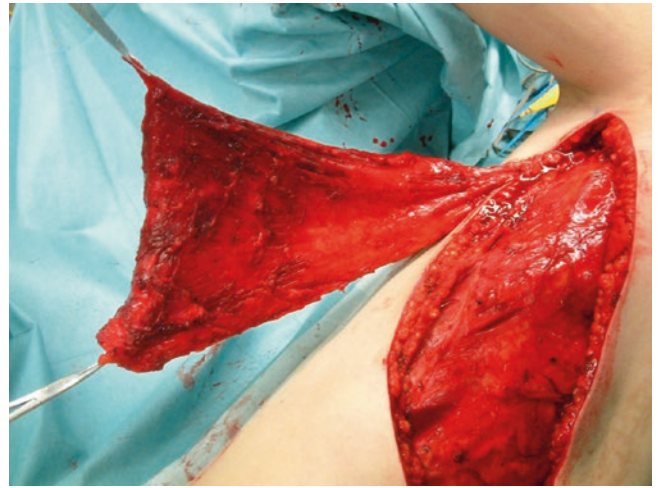


Fig. 1.4 Procedure 4: The elevated latissimus dorsi musculocutaneous flap is transferred to the elbow via the subcutaneous pocket of the upper arm



Fig. 1.5 Procedure 5: The skin defect area is covered with the muscle flap. A bolster suture is done to pull the flap into the subcutaneous layer



Fig. 1.6 Procedure 6: A split-thickness skin graft is conducted on top of the muscle flap. A tie-over bolster dressing is applied



Fig. 1.7 (a, b) Procedure 7: After surgery the range of motion of the elbow has improved and full extension became possible



Tips**Can also be used for covering bone exposure of the lateral elbow**

For use on the lateral elbow, if the flap is transferred with a skin island attached, it is appropriate for covering and protecting the olecranon.



Column**“Form ever follows function” LH Sullivan**

During the reconstruction following the Great Fire of Chicago, sky rise buildings began to emerge as a means of effectively utilizing space. The pioneers of that movement were the architects known as the Chicago School which included names such as William Holabird, Dankmar Adler and Frank Lloyd Wright, a famous architect in his own right.

One of the key figures in this Chicago group was Louis Sullivan. Sullivan asserted that both form and function were equally important. This expression comes from the architectural world, but it is just as important for a reconstructive surgeon. When asked whether to “choose form or function”

the only answer is “to choose both.” That is because form is also a part of function.

However, what is important is that it is not that function always follows form, but that form always follows function. In other words, it is always form that follows, and even though they go together, function is always one step ahead. Whether it be the human body, or the home or office where we live, when it boils down to it, the answer is function. If architecture aims for “ease of use and with good form also,” then reconstructive surgery aims for “good form, little pain and ease of use,” but if we take this one step further, it becomes “no pain, ease of use, and if there is good form – even better.” This order must never be confused.

Basic Principles

The proximal area of the forearm is rich with muscle tissue, and in many cases exposed bone or tendons can be covered with muscle tissue, and can normally be covered with a skin graft. If there are doubts about whether a skin graft will take in one stage, it is possible to first place an artificial dermis on the area and then perform skin grafting several weeks later. Therefore, the main cases where the forearm needs to be reconstructed by covering with a skin flap involve the distal half of the forearm where tendons are easily exposed.

The skin of both the medial and lateral side of the distal end of the forearm is thin, and exposure of tendons or bone/nerves are frequently encountered. In such cases it is necessary to cover with a thin flap. It is easier to avoid adhesion of tendons if a skin flap that is rich in adipose tissue with good blood flow is used. Here, there is no need for sensory function. The most practical flap is the abdominal flap, which is used either as a pedicled flap or a free flap, and made thinner by removal of fat.

Selectable Flaps and Surgical Procedures

Rotation flap/radial forearm flap • Pedicled abdominal flap • Free abdominal perforator flap
• Free groin flap • Pedicled latissimus dorsi muscle flap • Free scapular flap • Lateral upper arm flap (reverse flow, normal flow) • Skin graft and negative pressure wound therapy
• Anterolateral thigh flap



The difficulty level of each surgical procedure is shown subsequent to the procedure title (e.g., Level of Difficulty: 2). The levels range from 1 to 5, with level 1 indicating a preliminary level and level 5 indicating a very advanced level.

Rotation Flap/Radial Forearm Flap (Level of Difficulty: 1)

Information

Vascular pedicle Subcutaneous vascular plexus of forearm or radial artery perforator

Flap size It is possible to move the entire skin of the forearm

Advantage Simple with stable blood flow

Caution The flap is dissected above the proper fascia, and a fascial flap is elevated using the forearm fascia. The skin of the medial forearm can easily be rotated around the transverse axis, however extending it around the vertical axis can lead to contracture.



Operation Procedures



Fig. 2.1 (a, b) Procedure 1: A rotation flap is designed as a measure for moving the skin of the distal medial forearm. Dog ear correction is necessary after rotation of a skin flap at the end

Fig. 2.2 Procedure 2: The distal end of the skin is dissected from above the proper fascia, and the fascial flap containing the forearm fascia moved while being rotated, and the dog ear corrected



Pedicled Abdominal Flap (Level of Difficulty: 3)

Information

Vascular pedicle Superficial epigastric blood vessels

Flap size A width for which direct closure can be conducted, normally 8–10 cm. Can be made over 25 cm extending from pubic region

Advantage Stable blood flow. Comparatively simple surgical technique. Rich amount of tissue. The tip can be made thinner. By rolling the base of the skin flap and creating a tubed flap, there is no need to include lining for the flap, and because there is no raw surface, the patient can shower from an early stage. By creating a long tubed flap, it is possible to increase the level of freedom of the upper arm, preventing contraction of the shoulder joint

Disadvantage Surgery is conducted in two stages.



Operation Procedures

Fig. 2.3 Procedure 1: A trapezium shaped skin flap is designed on the abdomen region on the same side as the affected hand with either an upper pedicle or lower pedicle (the skin flap can be located anywhere as long as it is designed above the central axis of the lateral abdomen area, so the position of the flap should be determined according to the area that is to be covered by the flap)

Note A skin flap of at least 8 cm is required in order to create a tubed flap. If sufficient width is not secured at the base of the flap where large amounts of fat are present, the vascular pedicle will be pinched when in the tube state, which can lead to circulation failure, so care is required. The tip of the flap can be made to the required width, however the skin flap is made longer in order to secure greater freedom for the upper arm. Normally length is about double the width.

Refer to Section of “Reconstruction of dorsum of hand/Pedicled abdominal skin flap” in Chap. 3



Fig. 2.4 Procedure 2: The flap is dissected at the layer above the external oblique muscle. A broad area is dissected from the donor area and sutured closed

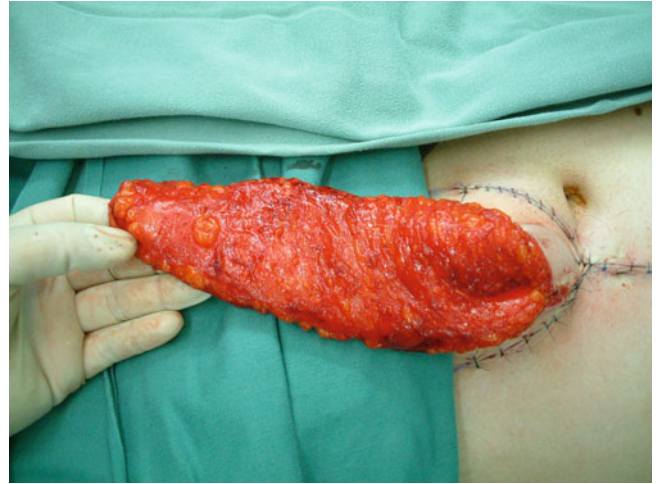


Fig. 2.5 Procedure 3: The part of the flap tip to be used for covering the wound is thinned by removing fat, based on the condition of the recipient site. A considerable amount can be removed as long as the subcutaneous vascular plexus is retained

Note For the area to be used for the tube flap, a large amount of fat is resected around the margin of the flap to ease tubing stress, but care must be taken for resecting excess fat near the superficial epigastric blood vessels.



Fig. 2.6 Procedure 4: The base of the flap is sutured and the entire flap made into a tube shape

Note Here, if the flap base is not wide enough, or the amount of fat is too thick, the vascular pedicle will be pinched, so care is required.



Fig. 2.7 Procedure 5: Case example of skin defect on medial forearm following re-attachment of the wrist. Exposure of the tendons present



Fig. 2.8 Procedure 6: Appearance of flap sutured to medial wrist. Care must be taken for the wound not be left exposed. As there is no wound exposure on the reverse side of the flap, the patient can shower after several days



Note Note that a long flap is created.

Apart from bandaging up the wrist or forearm, the only other fixing is made with an abdominal belt, and the shoulder joint is not fixed in place.

Fig. 2.9 Procedure 7: If the blood flow to the skin flap is temporarily blocked and the skin flap remains a healthy color, it means that new blood flow has been created on the attachment surface of the wound, and it is possible to separate the skin flap. Normally the skin flap is separated at about 2 weeks later



Note In cases where the attachment area of the skin flap is small, it can take up to 3 weeks before the skin flap is separated.

Tips**1. Temporarily block the blood flow of the vascular pedicle**

Regularly check that the base of the skin flap isn't bent due to postural change. Remove all dressings every 2 or 3 days, carry out movement of the elbow and shoulder, and have the patient take a shower. If there are no problems with skin flap circulation, from about day 10 onwards, cut off the blood flow from the abdomen to the skin flap pedicle for about 10 min each day using an intestinal clamp or tourniquet to encourage new generation of blood vessels between the flap and the wound.

**Tips****2. It is important to cut and suture in places that don't apply stress to the margins of the flap**

When cutting the flap, it is easy for the margin of the flap to become necrotic due to thinning of the fat from the separated flap. It is important that incisions and suturing are conducted without applying stress to the margins of the flap, and that thinning is conducted secondarily, even if it results in the flap becoming bulky (Fig. 2.15).



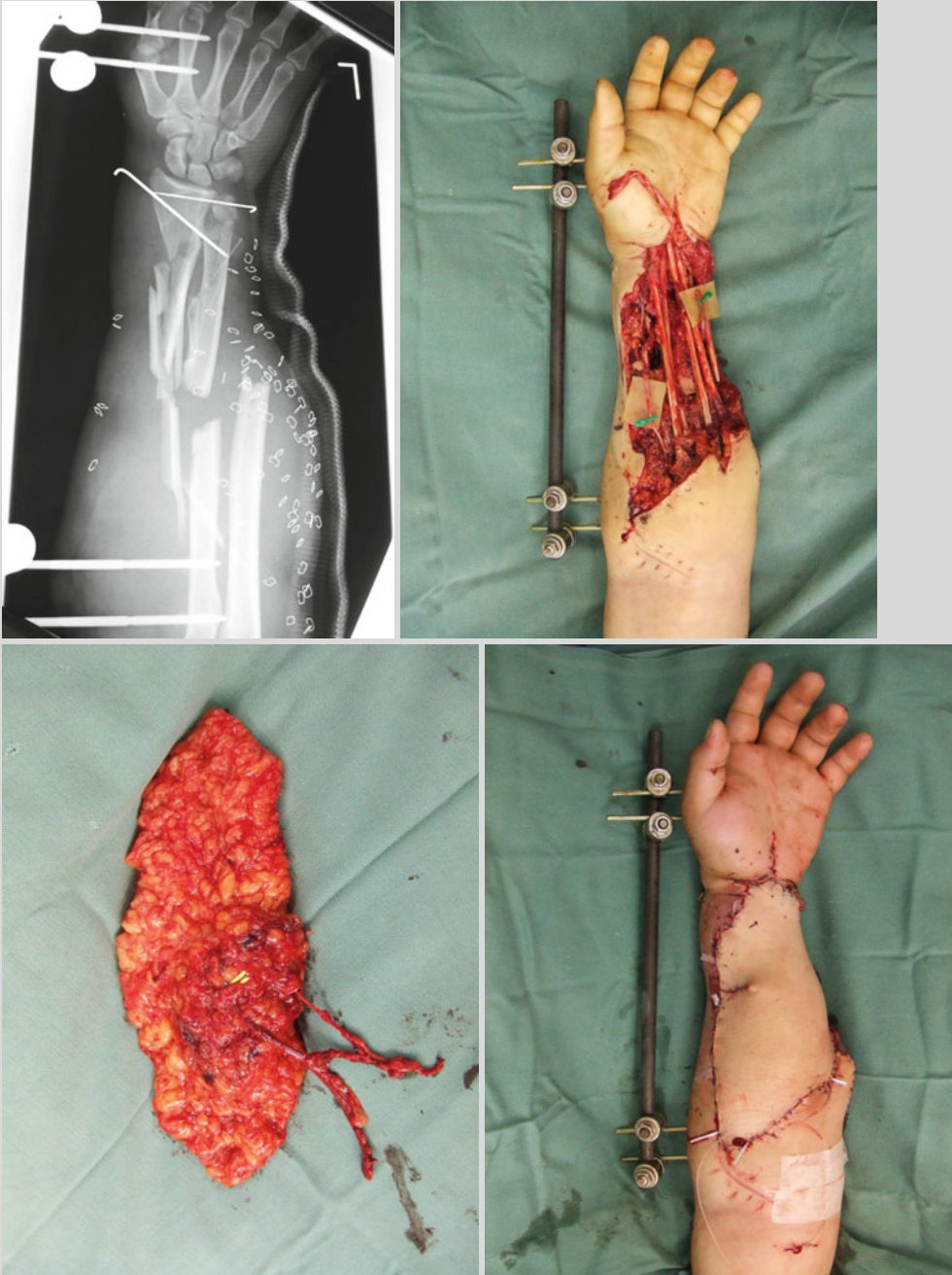
Free Abdominal Perforator Flap (Level of Difficulty: 4)**Information**

Vascular pedicle Deep inferior epigastric blood vessels and their perforators

Flap size No restriction as long as abdominal skin containing perforators is used

Advantage Few restrictions for the shape of the skin flap. Possible to remove fat and make the skin flap thinner. It is possible to conduct primary closure of the donor site

Disadvantage High risk in cases of advanced obesity



Operation Procedures

Fig. 2.10 Procedure 1: Case of open fracture accompanying soft tissue damage, and rupturing of all extensor tendons of the forearm. Debridement is carried out of necrotic tissue



Fig. 2.11 Procedure 2: A few perforators are present beneath this 4×4 cm section beside the naval area. The flap is designed in a horizontal or longitudinal direction, with the perforators included, and an incision made in the margin of the flap

Refer to Section of “Reconstruction of Achilles tendon area/Free abdominal perforator flap” in Chap. 17 and **Section of** “Reconstruction of dorsum of hand/Free abdominal perforator flap” in Chap. 3



Fig. 2.12 Procedure 3: Several perforators emerging from the anterior sheath of the rectus abdominis muscle are secured. The photo shows the flap turned-over in the longitudinal direction with the perforators marked

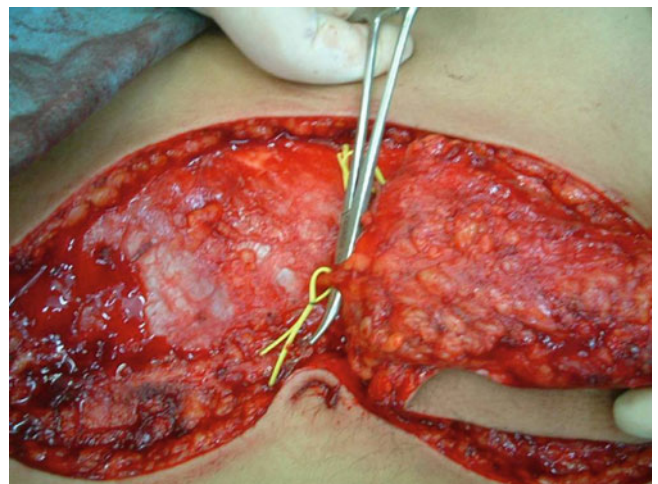


Fig. 2.13 Procedure 4: Several perforators running longitudinally in the direction of the rectus abdominis muscle fiber are selected, and the anterior sheath of the rectus abdominis is cut and dissected up to the deep inferior epigastric blood vessels. Apart from the area surrounding the perforators, fat can be removed and the skin flap which can be thinned to the thickness of the subcutaneous vascular plexus (1 cm). Thinning should be performed prior to severing the vascular pedicle

Note In order to prevent twisting of the vascular pedicle it is better to include at least two perforators. Also, by securing perforators that run in line with the muscle fiber, it is possible to minimize damage to the tissue.

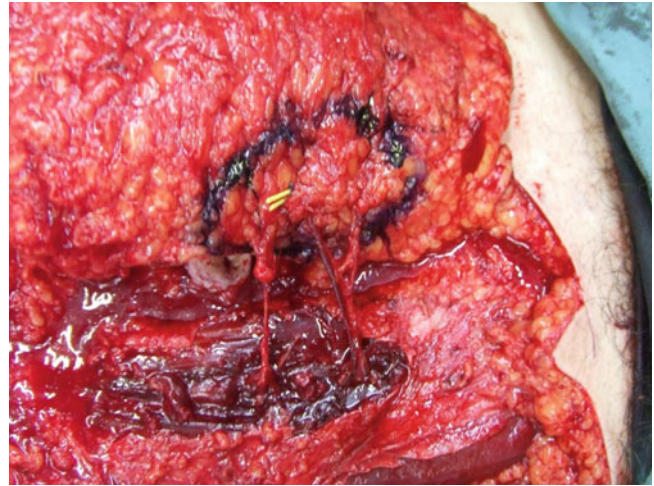


Fig. 2.14 Procedure 5: The skin flap is harvested with a long vascular pedicle

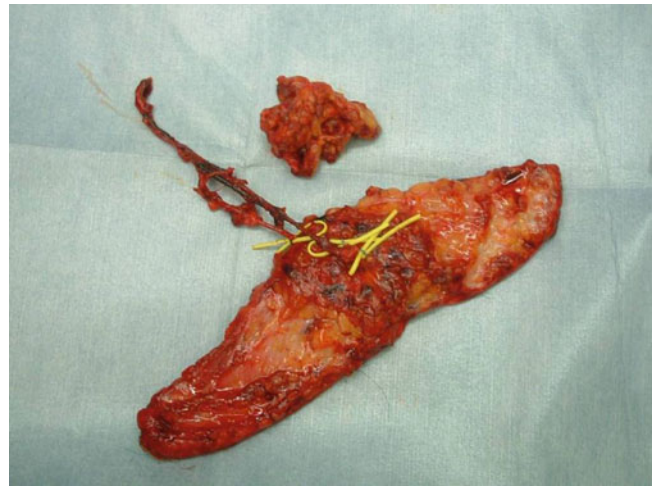


Fig. 2.15 Procedure 6: End-to-side anastomosis is conducted of the long vascular pedicle to the radial artery. End-to-end anastomosis is conducted for the comitant vein



Fig. 2.16 Procedure 7: The anterior sheath of the rectus abdominis is repaired and sutured closed. A continuous suction drain is inserted and the wound closed



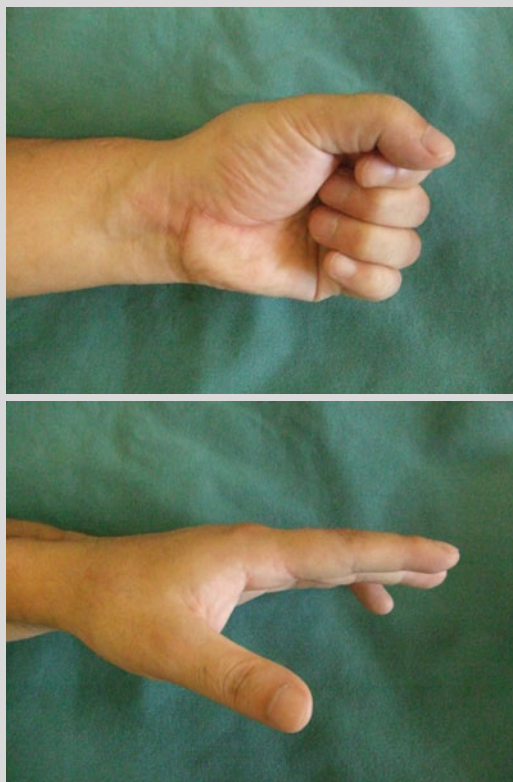
Tips

For infectious cases, tendon transfer is performed secondarily

In cases of multiple tendon injury and neuroparalysis it is theoretically possible to combine both free flap and tendon transfer. However for cases with infection present and for cases with long surgery times, covering properly with soft tissue first, and then performing tendon transfer or tendon transplant later on enables quicker rehabilitation and produces a better result. In the previously described example, tendon transfer was performed 2 months after attaching the skin flap.

With regard to wrist-drop from injury to all extensor tendons, the flexor carpi radialis tendons of the wrist are transferred through the interosseous membrane to the extensor digitorum muscle tendons with interlacing suture. Flexor digitorum suoerficialis tendon of the ring finger is cut at the attachment area and pulled into the carpal tunnel, passing beneath the median nerve/flexor tendon group/first compartment, and an interlacing suture is conducted to the extensor pollicis longus muscle tendon distal to the wrist.

That result is shown at below.



Free Groin Flap (Level of Difficulty: 4)**Information**

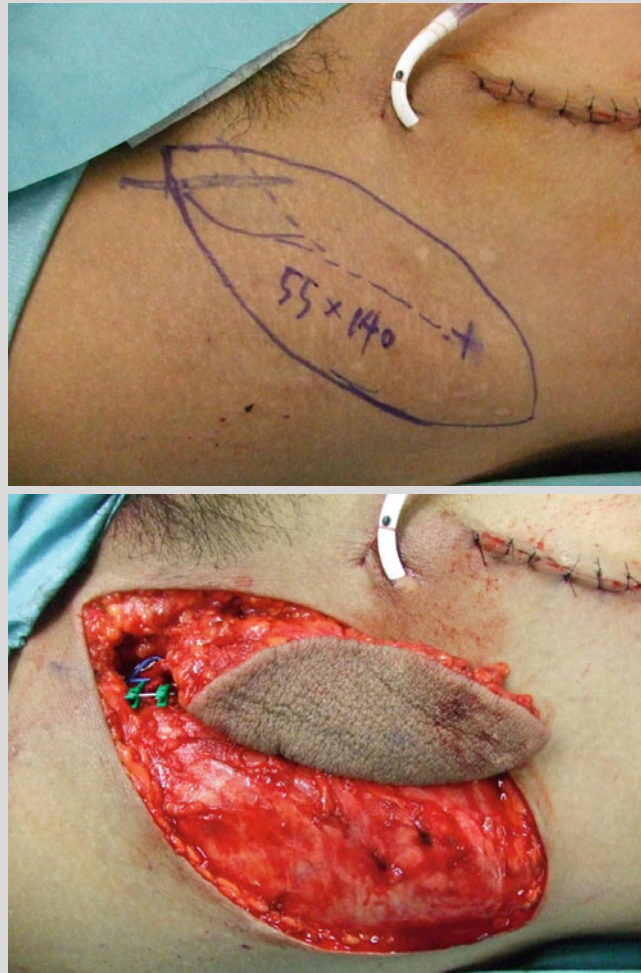
Vascular pedicle Superficial circumflex iliac blood vessel (at distal end branches into the superficial branch and deep branch, and superficial branch enters the flap). Length is 2 cm.

Flap size The width of the flap that can be sutured closed is around 10–15 cm centered around the inguinal ligament, and the length is up to about 25–30 cm, two times the length from the femoral artery to the anterior superior iliac spine.

Advantage Donor site can be sutured closed primarily and isn't obvious. Skin flap is comparatively thin, and large skin flap can be harvested.

Disadvantage There are often variations in the path of the superficial circumflex iliac artery. The vascular pedicle is short and small (1.5 mm). Fat tissue in the medial side of the flap (medial side of the femoral artery) is thick

Caution When dissecting the medial side of the anterior superior iliac spine, if going too deep, the lateral cutaneous nerve of the thigh can be damaged, so care is required.



Operation Procedures

Fig. 2.17 (a, b) Procedure 1: Scar tissue is resected from the dorsal part of the forearm and the ruptured extensor tendon group are dissected and identified



Fig. 2.18 (a, b) Procedure 2: The fascia latae is harvested, and wrapped and connected to the ruptured muscle group

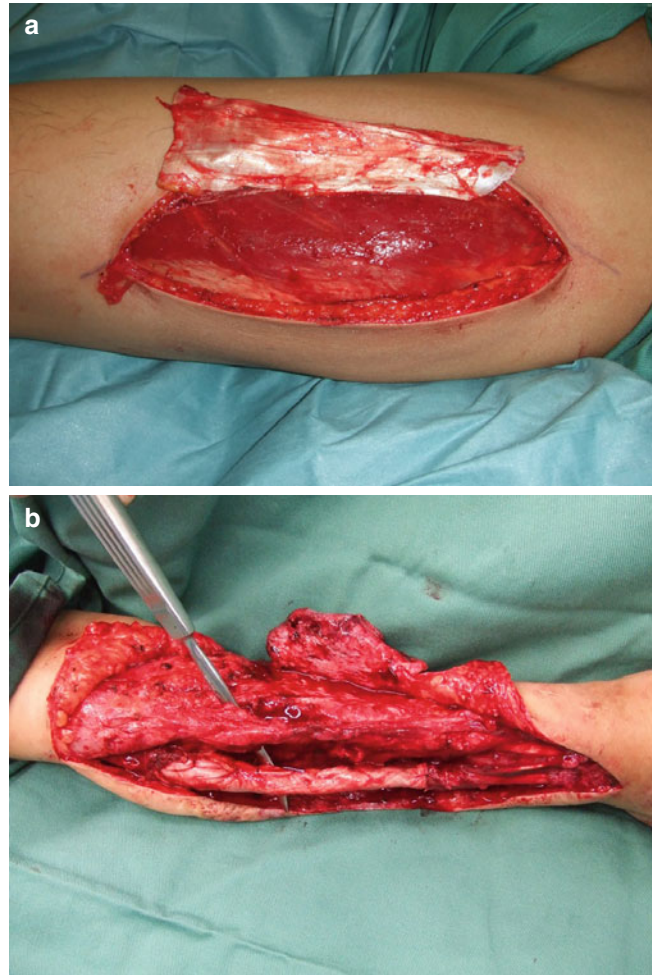


Fig. 2.19 Procedure 3: A mark is placed 2.5 cm distally from the inguinal ligament on the skin above the femoral artery, indicating the head of the superficial circumflex iliac artery. A line is drawn from here to the anterior superior iliac spine indicating the path of the superficial circumflex iliac artery, and this is used as the central axis of the flap design

