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One-stage reconstruction of facial paralysis associated with skin/soft tissue defects using latissimus dorsi compound flap☆

Akihiko Takushima[a,*], Kiyonori Harii[a], Hirotaka Asato[b], Akira Momosawa[a], Mutsumi Okazaki[b]

[a]*Department of Plastic and Reconstructive Surgery, School of Medicine, Kyorin University, 6-20-2, Shinkawa, Mitaka-shi, Tokyo 181-8611, Japan*
[b]*Department of Plastic and Reconstructive Surgery, Graduate School of Medicine, University of Tokyo, Tokyo, Japan*

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Summary Neurovascular free muscle transfer is now the mainstay for smile reconstruction in the treatment of established facial paralysis. Since facial paralysis due to ablative surgery or some specific disease sometimes accompanies defects of the facial skin and soft tissue, simultaneous reconstruction of defective tissues with facial reanimation is required. The present paper reports results for 16 patients who underwent reconstruction by simultaneous soft tissue flap transfer with latissimus dorsi muscle for smile reconstruction of the paralysed face. Soft tissue flaps comprised skin paddle overlying the latissimus dorsi muscle ($n=6$), serratus anterior musculocutaneous flap ($n=5$), serratus anterior muscle flap ($n=2$), and latissimus dorsi perforator-based flap with a small muscle cuff ($n=3$). The latissimus dorsi muscle can be elevated as a compound flap of various types, and thus offers the best option as a donor muscle for facial reanimation when soft tissue defects require simultaneous reconstruction.

Since Harii et al. in 1976[1] first reported successful transfer of the gracilis muscle with microneurovascular anastomoses for the treatment of long-standing facial paralysis, numerous kinds of muscle transfers have been developed as versatile donor muscle for dynamic reanimation of established facial paralysis, including the gracilis,[1,2] pectoralis minor,[3,4] abductor hallucis,[5] rectus abdominis,[6] latissimus dorsi[7,8] and serratus anterior.[9] However,

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* Corresponding author. Tel.: +81 422 47 5511; fax: +81 422 46 6138.
E-mail address: takushima-pla@umin.ac.jp (A. Takushima).

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facial paralysis due to ablative surgery around the parotid gland or various specific diseases often accompanies defects of the facial skin and soft tissue, in addition to facial paralysis. Simultaneous reconstruction of skin and soft tissue defects and facial paralysis is generally preferable. On such occasions, choice of muscle transfer for facial reanimation should be limited to those that can be harvested as a musculocutaneous flap or an accompanying soft tissue flap. Chuang et al. reported this type of reconstruction using the gracilis muscle and associated skin compound flap.[10] However, the latissimus dorsi muscle appears useful due to the long and sizable thoracodorsal vascular stalk and the ability to elevate with various kinds of soft tissue flaps nourished by a common trunk with the thoracodorsal vessels. The present paper describes results for 16 patients who underwent simultaneous soft tissue flap transfer with the latissimus dorsi muscle for smile reconstruction of facial paralysis, and discusses the versatility of the latissimus dorsi muscle.

Materials and methods

Patient profiles

Between January 1977 and March 2003, latissimus dorsi free muscle transfer was performed for 249 patients with facial paralysis. Of these, 16 patients (6.4%; 10 women, six men) received simultaneous soft tissue reconstruction using latissimus dorsi transfer. Mean age was 41 years (range, 13-71 years). Morbidities resulting in facial paralysis involved ablative surgery around the buccal or parotid region in all patients except one (Table 1). Of the 16 patients, six underwent primary reconstruction when ablative surgery was performed, while 10 underwent secondary facial reconstruction after facial paralysis had become established. Types of soft tissue flap transferred simultaneously with latissimus dorsi muscle for facial reanimation included skin paddle overlying the latissimus dorsi muscle ($n=6$), serratus anterior musculocutaneous flap ($n=5$), serratus anterior muscle flap ($n=2$), and latissimus dorsi perforator-based flap with a small muscle cuff ($n=3$) (Table 2). The ipsilateral facial nerve stump was selected as a motor source[11] for innevating transferred muscle in eight patients, while the contralateral facial nerve branches were used as recipients[8] in the remaining eight patients. No patients used a motor nerve source other than the facial nerve.

Table 1 Simultaneous soft tissue reconstruction cases

Morbidity	No. of patients
Parotid gland tumor	9
Lymphangioma	2
External ear canal carcinoma	2
Hemangioma	1
Maxillary carcinoma	1
Hemifacial microsomia	1
Total	16

Table 2

Type of soft tissue flap	No. of patients
Skin paddle overlying latissimus dorsi muscle	6
Serratus anterior musculocutaneous flap	5
Serratus anterior muscle flap	2
Latissimus dorsi perforator-based flap	3
Total	16

Operative procedures

Conventional operative procedures for harvesting a neurovascular latissimus dorsi muscle for facial reanimation have previously been described in detail by Harii et al.[8] In brief, through a skin incision along the posterior axillary line, the thoracodorsal vessels and nerve are first dissected. After obtaining a sufficient length of thoracodorsal nerve, a muscle segment of the required size is harvested. When soft tissue flap is required, other operative procedures are added with slight modification of the latissimus dorsi muscle harvesting.

Latissimus dorsi musculocutaneous flap

Extensive ablative surgeries in the parotid or buccal regions sometimes require primary reconstruction of facial skin along with the mimetic muscles. Under such conditions, since the defective area is almost the same as the place where the neurovascular free muscle for facial reanimation is inset, a skin paddle overlying the latissimus dorsi muscle for facial reanimation is selected as a musculocutaneous flap.

A skin paddle of the required size is marked on the latissimus dorsi muscle before harvesting the flap. Without any dissection between the skin paddle and muscle segment to avoid vascular impairment, the latissimus dorsi muscle for facial reanimation is elevated as a conventional musculocutaneous flap.

Serratus anterior musculocutaneous/muscle flap

When the soft tissue defect is relatively large and the defect site is distant to the buccal pocket where the latissimus dorsi muscle for facial reanimation is inset, a serratus anterior musculocutaneous or muscle flap is selected for soft tissue augmentation.

A skin paddle is first marked on the serratus anterior muscle simultaneously to design of the latissimus dorsi flap, and elevated as a musculocutaneous flap nourished by a common trunk with the thoracodorsal nutrient vessels of the latissimus dorsi muscle.[12] The serratus anterior muscle is then trimmed so that the skin/dermal and fat portions fit the defective space, although the muscle itself may become rather atrophic later.

Latissimus dorsi perforator-based flap with small muscle cuff

When the soft tissue defect is relatively small, two segmental latissimus dorsi flaps are selected, nourished by the anterior and posterior branches of the thoracodorsal vessels, respectively. One segment is used for facial reanimation as a neurovascular muscle flap, and the other is used for soft tissue reconstruction as a perforator-based flap with a small muscle cuff.

A skin paddle is marked near and dorsal to the anterior edge of the thoracodorsal muscle. After wide dissection of the latissimus dorsi muscle with a skin paddle, anterior and posterior branches of the thoracodorsal vessels and the nerve that runs on the deep surface of the latissimus dorsi are dissected. In the usual latissimus dorsi muscle harvesting for facial reanimation,[8] a muscle segment nourished by the anterior branch vessels is employed. This is because the anterior segment of the latissimus dorsi muscle is rather thin and fits well into the cheek contour with only slight muscle thinning. However, since the skin paddle locates on top of the anterior muscle segment, the posterior muscle segment is used for facial reanimation by securing the posterior branch of the thoracodorsal nerve. The anterior branch of the thoracodorsal nerve is thus severed and the anterior muscle segment with a skin paddle is used for soft tissue reconstruction. In order to avoid the effect of postoperative muscle atrophy, muscle volume is reduced so that the flap can be elevated as a perforator based flap with a small muscle cuff.

Results

All patients underwent successful transfer, but voluntary contraction of grafted muscle was not observed in one patient who underwent latissimus dorsi muscle transfer with serratus anterior muscle.

Case reports

Case 1 (Fig. 1)

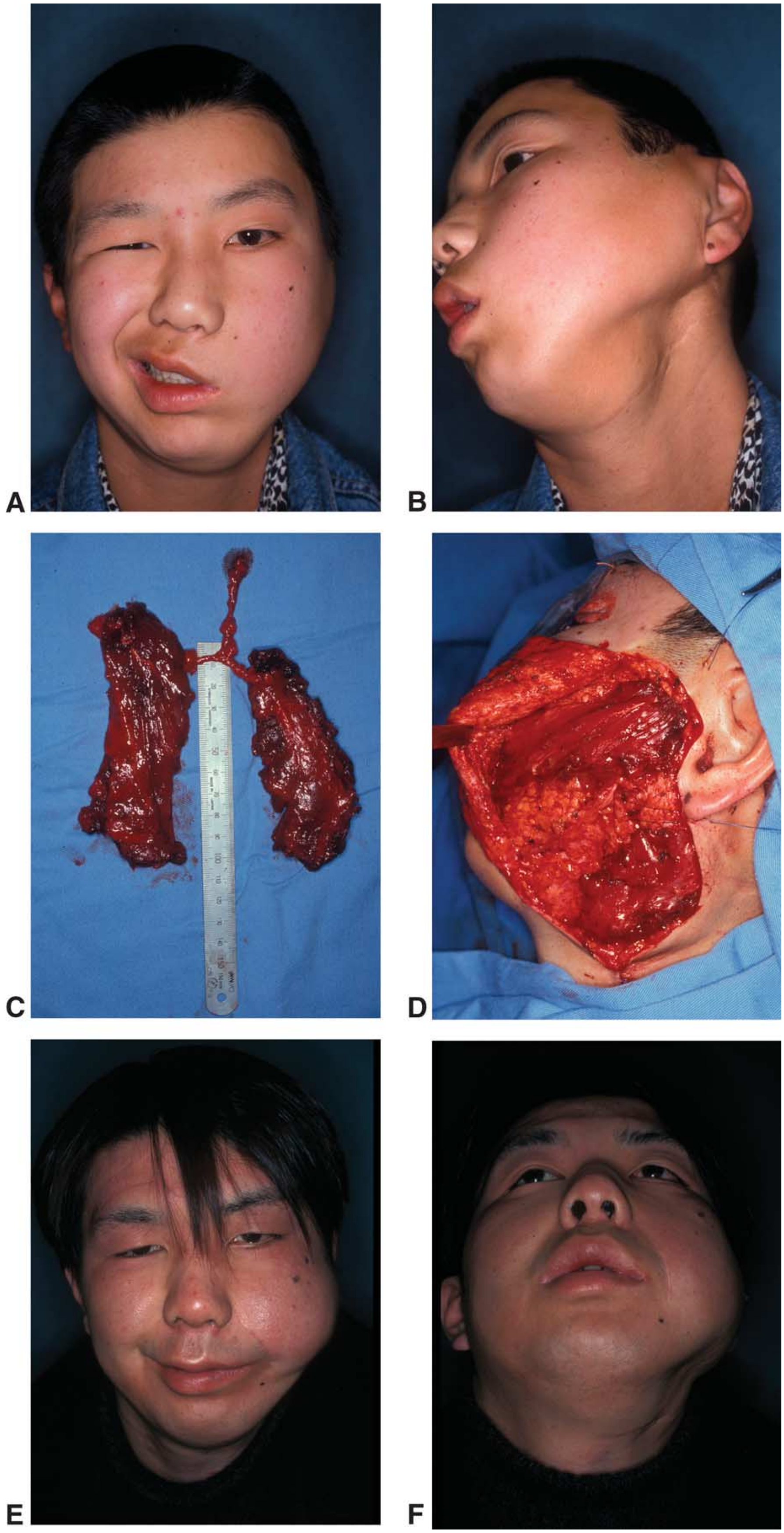
A 13-year-old boy had developed congenital lymphangioma of the left parotid and submandibular regions. The tumor was resected at 1-year-old, resulting in facial paralysis and a large soft tissue defect in the submandibular area. One year after cross-face nerve graft using the sural nerve, established facial paralysis was reconstructed using a neurovascular latissimus dorsi free muscle transfer and the soft tissue defect was reconstructed using a serratus anterior muscle flap. The ipsilateral superior thyroid artery and internal jugular vein were used for vascular anastomoses. By 5 years postoperatively, after revisional operation to the nasolabial fold line and bulkiness of the cheek, facial symmetry on smiling was improved and submandibular contour was almost restored.

Case 2 (Fig. 2)

A 69-year-old woman underwent extensive ablative surgery for squamous cell carcinoma of the right external ear canal. Although the temporal cranial base was primarily reconstructed using a rectus abdominis musculocutaneous flap, facial paralysis and severe deformity in the temporal region remained. These were reconstructed using the latissimus dorsi muscle for facial reanimation and denuded serratus anterior musculocutaneous flap for soft tissue deformity. Vessels suitable for vascular anastomosis on the ipsilateral side could not be found, so contralateral facial vessels were used with an interpositional graft of the radial vessels. Contralateral facial nerve branches were selected as the motor nerve. As of 2 years postoperatively, muscle movement remains well recognized.

Case 3 (Fig. 3)

A 45-year-old woman presented with complete left facial paralysis following ablative surgery for Warthin tumor. Since a depressed deformity of the parotid region was not particularly large,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de-epithelialised latissimus dorsi perforator-based flap with a small muscle cuff was transferred in combination with the latissimus dorsi muscle for facial reanimation. Thoracodorsal vessels nourishing both flaps were anastomosed to the facial vessels and the thoracodorsal nerve was sutured to the contralateral facial nerve branches. Upper eyelid loading with a gold plate and endoscopic eyebrow lift on the paralysed side were performed as ancillary procedures. Muscle contraction was first recognized 7 months after neurovascular free muscle transfer. As of 2 years postoperatively, the patient has achieved a near-natural smile with symmetrical facial contours.

Discussion

Facial paralysis accompanied by defects of the skin and soft tissues presents further challenges to the neurovascular free muscle transfer developed for the treatment of established facial paralysis. Harii et al.[13] reported a case of facial paralysis with soft tissue defect in the cheek due to ablative surgery for cavernous hemangioma. That defect was reconstructed using a latissimus dorsi muscle and skin paddle compound flap. Although some cases have been reported since,[14-16] no consecutive cases have been described other than a report by Chuang et al.[10] They employed a gracilis muscle and skin paddle compound flap for simultaneous facial paralysis and skin/soft tissue reconstruction for eight patients. However, skin/soft tissue defects accompanied by facial paralysis vary greatly in size and position depending on the cause of facial paralysis, and managing all patients using a skin paddle on the gracilis muscle may be difficult.

Defects of the skin and soft tissue that should be reconstructed using neurovascular free muscle for facial reanimation can be classified into several categories, depending on the site of the skin/soft tissue defect. One is skin and/or oral mucosa and soft tissue defect with resection of facial mimetic muscles in the cheek. Extensive resection of buccal carcinoma or large vascular malformation displays this type of defect. To reconstruct this type of defect, since the skin/mucosal and soft tissue defect sites exist just above or beneath the site where the neurovascular free muscle for facial reanimation is inset, primary reconstruction using the neurovascular muscle and overlying skin paddle compound flap should be selected. Under such circumstances, since the proximal stump of the ipsilateral facial nerve can almost always be secured as a motor source, a long nerve pedicle is not required. Musculocutaneous compound flaps represented by the gracilis, rectus abdominis, and latissimus dorsi muscles represent good candidates for suitable donor muscles.

The second type involves skin/soft tissue defects in the infra-auricular region, while the third type is present in other areas including the temporal and lateral orbital regions. To reconstruct these types of defect, the muscle flap for facial reanimation and skin flap for skin/soft tissue defect must be inset separately. Chuang et al. noted that a gracilis muscle and the associated skin paddle can be inset separately by isolating the perforators between the muscle and skin/soft tissue segments. However, the possibility remains that excessive rotation and movement for a proper flap setting may impair vascularity of the skin paddle. Applying two separate flaps that can be placed without restraining each other is thus a natural solution. Use of two compound two flaps that share a common vascular trunk is thus recommended. Since skin/soft tissue defects of these types are often deep in the parotid or temporal area and the ipsilateral facial nerve is often completely resected, another source should be employed including the hypoglossal nerve or contralateral facial nerve branch. Although the hypoglossal nerve is a powerful source for transferred muscle, movement of the transferred muscle is neither natural nor synchronous to the healthy side, as reported by Ueda et al.[17] We thus believe that the latissimus dorsi muscle has a long enough nerve to reach the contralateral facial nerve branch,[8] and offers the best option for these types of tissue defects.

The latissimus dorsi muscle, as many authors have reported, can be elevated as a combined flap with other flaps such as serratus anterior flap and scapular flap on a single pedicle.[12,18-22] The thoracodorsal vessels divide into branches to nourish both the latissimus dorsi and serratus anterior muscles. As reported previously,[23] the latissimus dorsi and serratus anterior musculocutaneous flap can be harvested as a combined flap for facial reanimation and soft tissue augmentation, respectively. However, position of the skin paddle

Figure 1 Case 1. (a) Preoperative appearance on smiling. (b) Severe deformity in the submandibular region is evident. (c) The latissimus dorsi muscle and serratus anterior muscle were harvested. (d) The latissimus dorsi muscle was used for reanimation and serratus anterior muscle was used for soft tissue augmentation. (e) Five years postoperatively on smiling. (f) Submandibular soft tissue defect is almost restored.

Figure 2 Case 2. (a) Preoperative appearance at rest. (b) Preoperative appearance on smiling. (c) Severe deformity in the temporal region was evident. (d) The latissimus dorsi muscle and the deepithelialised serratus anterior musculocutaneous combined flaps were transferred. (e) Two years postoperatively at rest. (f) Two years postoperatively on smiling. (g) Temporal deformity is almost restored.

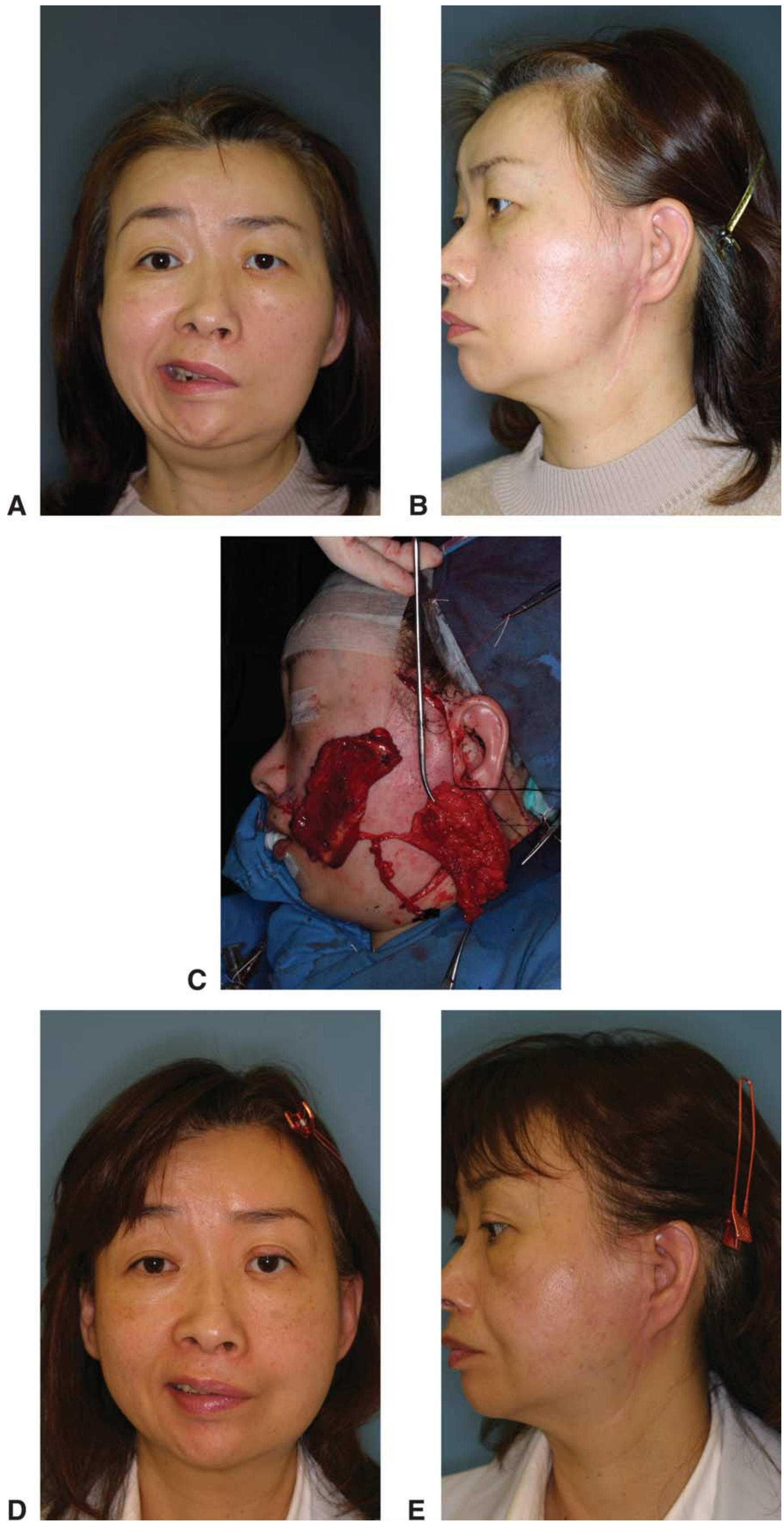

Figure 3 Case 3. (a) Preoperative appearance on smiling. (b) Slight deformity in the parotid area is recognized. (c) The latissimus dorsi combined flaps were transferred. (d) One year postoperatively on smiling. (e) Temporal deformity is well restored.

for serratus anterior musculocutaneous flap is anterior to the posterior axillary line, where the latissimus dorsi muscle is harvested, resulting in a rather conspicuous scar near the anterior chest. To overcome this problem, we developed two segmental flaps of latissimus dorsi muscle. As Maasarany and Zhao reported from their anatomical research,[24,25] the thoracodorsal artery divides into medial and lateral branches on the deep surface of the latissimus dorsi muscle. A segmental muscle nourished by a single branch is also transferred safely in clinical settings.[26–29] One segment was thus used for facial reanimation as a neurovascular muscle flap, while the other was used for skin/soft tissue reconstruction as a perforator-based flap with a small muscle cuff. One disadvantage of using two segmental flaps of the latissimus dorsi muscle is that it allows less freedom of placement compared to the latissimus dorsi and serratus anterior musculocutaneous flaps. Two segmental flaps of latissimus dorsi muscle should be used when the skin/soft tissue defect is in the infra-auricular region close to the buccal pocket where the muscle segment will be placed. Conversely, latissimus dorsi and serratus anterior musculocutaneous compound flaps should be used when the skin/soft tissue defect is distant from the buccal pocket, such as in the temporal region.

In conclusion, latissimus dorsi muscle flaps can be elevated as various types, including with a skin paddle, with a serratus anterior musculocutaneous flap, and as two segmental flaps. The latissimus dorsi muscle thus represents the best option as a donor muscle for facial reanimation when the soft tissue defect requires simultaneous restoration.

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