# Neurovascularized Free Short Head of the Biceps Femoris Muscle Transfer for One-Stage Reanimation of Facial Paralysis

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The single-stage technique for cross-face reanimation of the paralyzed face without nerve graft is an improvement over the two-stage procedure because it results in early reinnervation of the transferred muscle and shortens the period of rehabilitation. On the basis of an anatomic investigation, the short head of the biceps femoris muscle with attached lateral intermuscular septum of the thigh was identified as a new candidate for microneurovascular free muscle transfer. The authors performed one-stage transfer of the short head of the biceps femoris muscle with a long motor nerve for reanimation of established facial paralysis in seven patients. The dominant nutrient vessels of the short head were the profunda perforators (second or third) in six patients and the direct branches from the popliteal vessels in one patient. The recipient vessels were the facial vessels in all cases. The length of the motor nerve of the short head ranged from 10 to 16 cm, and it was sutured directly to several zygomatic and buccal branches of the contralateral facial nerve in six patients. One patient required an interpositional nerve graft of 3 cm to reach the suitable facial nerve branches on the intact side. The period required for initial voluntary movement of the transferred muscles ranged from 4 to 10 months after the procedures. The period of postoperative follow-up ranged from 5 to 42 months. Transfer of the vascularized innervated short head of the biceps femoris muscle is thought to be an alternative for one-stage reconstruction of the paralyzed face because of the reliable vascular anatomy of the muscle and because it allows two teams to operate together without the need to reposition the patient. The nerve to the short head of the biceps femoris enters the side opposite the vascular pedicle of the muscle belly, and this unique relationship between the vascular pedicle and the motor nerve is anatomically suitable for one-stage reconstruction of the paralyzed face. As much as to 16 cm of the nerve can be harvested, and the nerve is long enough to reach the contralateral intact facial nerve in almost all cases. The lateral intermuscular septum, which is attached to the short head, provides "anchor/suture-bearing" tissue, allowing reliable fixations to the zygoma and the upper and lower lips to be achieved. In addition, the scar and deformity of the donor site are acceptable, and loss of this muscle does not result in donor-site dysfunction. (*Plast. Reconstr. Surg.* 115: 394, 2005.)

The aims of reconstruction of longstanding facial paralysis are to restore symmetry of facial muscle tone at rest, voluntary facial movements, and involuntary facial expressions.[1] A

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one-stage free-muscle transfer in which the motor nerve is directly crossed through the face and sutured to the contralateral facial nerve branches is probably the optimal method, and in the 1990s successful reconstructions were reported using the gracilis,[2] rectus femoris,[3] abductor hallucis,[4] and latissimus dorsi[5] muscles.

Recently, the short head of the biceps femoris muscle with attached lateral intermuscular septum of the thigh was identified as a new candidate for microneurovascular free muscle transfer.[6] The second and third profunda perforators enter the medial side of the proximal half of the short head of the biceps femoris. One of these profunda perforators sends a long branch that courses obliquely and inferiorly through the mid-layer of the muscle to serve as the dominant blood supply of the short head. The motor nerve to the short head of the biceps femoris is a branch of the common peroneal division of the sciatic nerve, which descends and then enters the lateral side of the mid-portion of the muscle (Fig. 1). With this unique neurovascular anatomy (i.e., a long motor nerve and dominant nutrient vessels entering from opposite sides of the muscle belly), the short head of the biceps femoris muscle with lateral intermuscular septum presents a suitable neurovascular unit for one-stage reconstruction of the paralyzed face.

In this report we describe a technique for one-stage transfer of the short head of the biceps femoris muscle for reanimation of established facial paralysis. The motor nerve of the short head is crossed through the upper lip and sutured to the contralateral zygomatic and buccal branches of the facial nerve.

## Clinical Anatomy

Twelve lower limbs from six fixed adult cadavers were dissected to reappraise the neurovascular anatomy of the short head of the biceps femoris muscle and the relationship between the short head and surrounding muscles and fascia.

The short head of the biceps femoris muscle originates from the femur and the lateral intermuscular septum of the thigh and inserts into the head of the fibula. The lateral intermuscular septum of the thigh is continuous with the fascia lata and is attached to the whole of the linea aspera and its prolongations above and below. It is a strong tendinous membrane that extends from the attachment of the gluteus maximus to the lateral condyle. Tendinous fibers of the gluteus maximus insert into the proximal quarter and the short head of the biceps femoris attaches to the distal three quarters of the posterior aspect of the lateral intermuscular septum.

Regarding the blood supply to the short head of the biceps femoris, the second and third profunda perforators enter the medial side of the proximal half of the short head of the biceps femoris. One of these profunda perforators sends a long branch that courses obliquely and inferiorly through the mid-layer of the muscle to serve as the dominant blood supply of the short head (Fig. 2). Each pro-

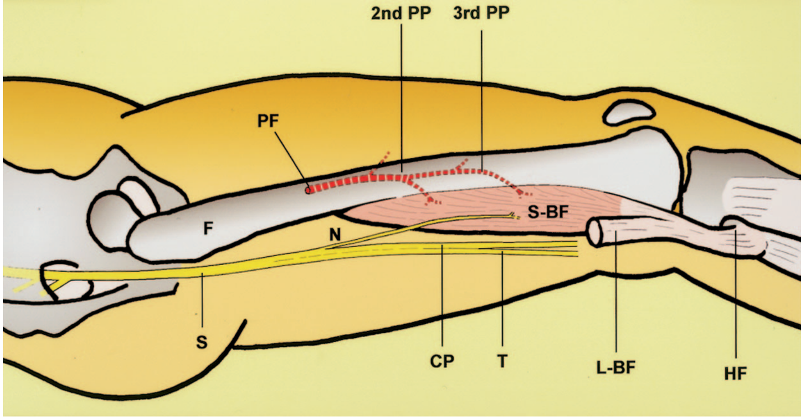


Fig. 1. Schema of lateral view of the right thigh. The short head of the biceps femoris muscle (*S-BF*) arises from the lateral lip of the linea aspera of the femur (*F*) and from the lateral intermuscular septum. The muscle fibers of the short head join the tendon of the long head (*L-BF*) and are attached mostly to the head of the fibula (*HF*). *S*, sciatic nerve; *CP*, common peroneal division; *N*, motor nerve of the short head; *T*, tibial nerve; *PF*, profunda femoris artery; *PP*, profunda perforator.

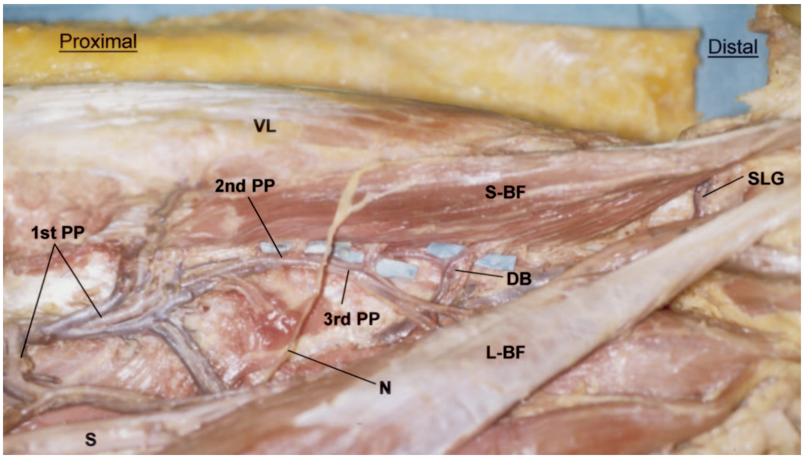


FIG. 2. Cadaver dissection showing the distal half of the right thigh (posterolateral view). The long head of the biceps femoris (*L-BF*) is detached from the short head and retracted posteriorly, and the adductor magnus is removed partially to show profunda perforators. Note that branches from the second and third profunda perforators, the direct branch from the popliteal artery (*DB*), and the superior lateral genicular artery (*SLG*) enter the side opposite the motor nerve of the muscle belly of the short head. *S,* sciatic nerve; *N*, motor nerve of the short head; *PP*, profunda perforator; *S-BF*, short head of the biceps femoris muscle; *VL*, vastus lateralis.

funda perforator gives off lateral fasciocutaneous branches that pass laterally to emerge where the lateral intermuscular septum meets the iliotibial tract and supply the skin of the lateral thigh, and also has anterior branches that curve around the femur and pass through the lateral intermuscular septum to enter the posterior part of the vastus lateralis to supply it. These lateral and anterior branches of the profunda perforators contribute little to the blood supply of the short head of the biceps femoris. The superior lateral genicular artery sends a branch to the short head of the biceps femoris at its lower end. This muscular branch ascends within the short head obliquely and superiorly toward the femoral shaft and finally penetrates the lateral intermuscular septum to reach the vastus lateralis (Fig. 3). Occasionally, a direct branch from the popliteal artery enters the short head of the biceps femoris in the area between the third profunda perforator and the superior lateral genicular artery. The third profunda perforator was the dominant nutrient artery of the short head of the biceps femoris in seven of 12 examined lower extremities, and the second profunda perforator was dominant in four of 12 limbs. The other limb showed a large dominant muscular branch from the superior lateral genicular artery. The external diameter of the dominant perforating artery of the profunda femoris at the point where it entered the short head ranged from 1.0 to 1.2 mm, and it could be dissected proximally for 5 to 8 cm beyond the second profunda perforator; the external diameter ranged from 1.4 to 2.0 mm at this level. The profunda perforators are always accompanied by venae comitantes.[6]

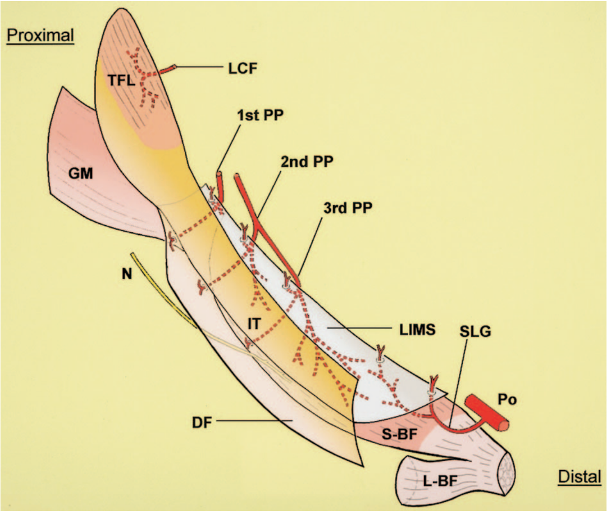


FIG. 3. Illustration of the neurovascular supply relating to the short head of the biceps femoris and surrounding muscles and fascia. *LIMS*, lateral intermuscular septum; *IT*, iliotibial tract; *DF*, posterior deep fascia; *TFL*, tensor fasciae latae; *GM*, gluteus maximus; *Po*, popliteal artery; *LCF*, lateral circumflex femoral artery; *N*, motor nerve of the short head; *PP*, profunda perforator; *S-BF*, short head of the biceps femoris muscle; *L-BF*, tendon of the long head.

The motor nerve to the short head of the biceps femoris is a branch of the common peroneal division of the sciatic nerve, which descends for 8 to 13 cm then enters the lateral surface of the midportion of the muscle (Figs. 2 and 3). After entering the short head of the biceps femoris muscle, both nutrient vessels and motor nerve run through the mid-layer of the muscle.[6] Not only the medial hamstring (semitendinosus and semimembranosus muscles) but also the long head of the biceps femoris receive one to two branches of the tibial division of the sciatic nerve (Fig. 4). The motor nerve of the short head runs mostly superficially to the common peroneal division of the sciatic nerve, so a further 3 to 5 cm of the motor nerve can easily be gained by intraneural dissection (Fig. 5). This procedure would not injure motor nerves of the other hamstring muscles because the motor nerve of the short head arises from the common peroneal nerve whereas motor nerves of the other hamstring muscles arise from the tibial nerve.

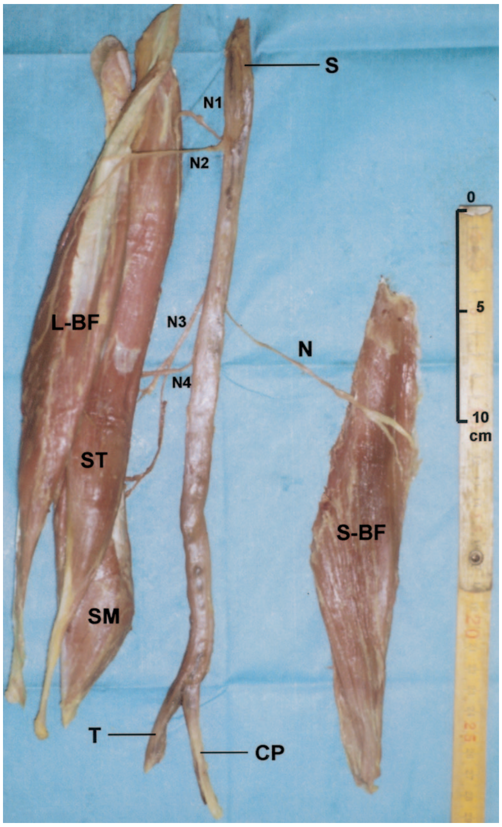


FIG. 4. Cadaver dissection of the right thigh demonstrating the motor nerve supply of hamstring muscles (viewing from the posterior aspect). Note that the motor nerve to the short head of the biceps femoris (*N*) arises from the common peroneal division (*CP*) of the sciatic nerve (*S*) whereas motor nerves of the other hamstring muscles (*N1, N2, N3, and N4*) arise from the tibial nerve (*T*). *S-BF*, short head of the biceps femoris muscle; *L-BF*, long head of the biceps femoris muscle; *ST*, semitendinosus; *SM*, semimembranosus.

## SURGICAL TECHNIQUE

### *Preparation of Donor Muscle*

The ipsilateral short head of the biceps femoris muscle is usually used for transfer. The patient is placed in the supine position with a pillow inserted under the buttock and with 30 degrees flexion of the hip joint. A tourniquet is not used because an accurate dissection of anatomical layers causes minimal blood loss and sometimes the surgeon can feel the palpitations of the profunda perforators to locate them. Furthermore, a tourniquet may be obstructive when intraneural dissection of the motor nerve of the short head is required. Two separate surgical teams perform simultaneous approaches to both donor and recipient sites.

A skin incision approximately 15 cm long is made on the lower lateral thigh, and suprafascial dissections are performed both anteriorly and posteriorly. A longitudinal fascial incision just anterior to the junction of the lateral intermuscular septum to the fascia lata is made, and the vastus lateralis muscle is exposed. Subfascial dissection reaches the anterior surface of the lateral intermuscular septum, then the muscle attachment of the vastus lateralis to the anterior surface of the lateral intermuscular septum is dissected to the femoral shaft. When the vastus lateralis is retracted anteriorly, a series of perforating branches can be identified penetrating the lateral intermuscular septum near the shaft of the femur to reach the vastus lateralis. These are anterior branches from the first to third profunda perforators and the superior lateral genicular artery or direct branch from the popliteal artery (Fig. 6, *above*). The points where nutrient vessels enter the short head of the biceps femoris muscle can be estimated by locating these anterior branches. A second fascial incision is made parallel and just posterior to the lateral intermuscular septum, and the biceps femoris muscle is exposed. The short head of the biceps femoris muscle is isolated by retracting the long head of this muscle posteriorly. The motor nerve of the short head can be easily identified at the lateral side of the muscle belly (Fig. 6, *below*). The sciatic nerve can be located deeply in the space between the

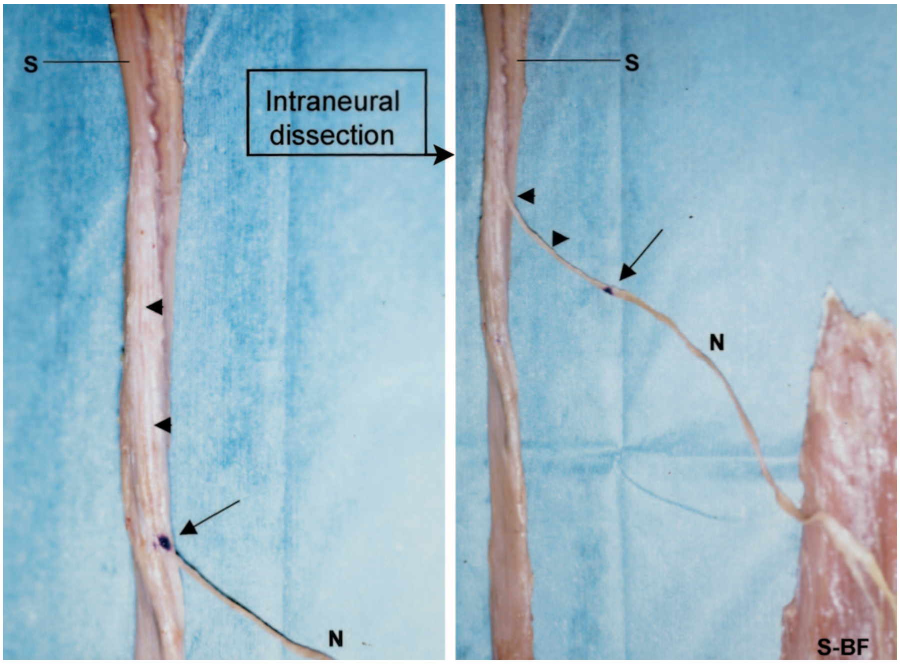


FIG. 5. Cadaver dissection demonstrating intraneural dissection of the motor nerve of the short head of the biceps femoris. Because the motor nerve of the short head (*N*) runs mostly superficially (*arrowheads*) to the common peroneal division of the sciatic nerve (*S*), a further several centimeters of the motor nerve can be gained from its origin (*arrows*) by blunt dissection. *S-BF*, short head of the biceps femoris muscle.

short and long head of the biceps femoris muscle. The motor nerve of the short head is dissected proximally to reach the common peroneal nerve, and a further 3 to 5 cm of the motor nerve can easily be gained by proximal intraneural dissection of the sciatic nerve if necessary. Attachments of both the short head of the biceps femoris muscle and the lateral intermuscular septum to the femur are dissected, and the anterior branches of profunda perforators and superior lateral genicular artery are ligated. The third and then the second profunda perforators descending posteriorly to the femoral shaft and entering the medial side of the short head can be palpated and identified, and the dominant one is dissected proximally for 5 to 8 cm. Finally, a muscle cuff of the short head measuring 10 cm long and 4 to 6 cm wide, including the motor nerve and nutrient vessels in its proximal portion, is dissected by cutting the lateral intermuscular septum and the short head of the biceps femoris muscle both proximally and distally. Thus, a neurovascularized muscle flap, composed of the short head of the biceps femoris muscle and the lateral intermuscular septum, is harvested (Fig. 7).

*Recipient Site*

A parotidectomy incision with a submandibular extension is used to create a subcutaneous pocket to accept the subsequent muscle transfer. A 4-cm-long incision is made in the ipsilateral nasolabial fold and dissected to the subcutaneous pocket, and undermining is extended medially for approximately 1.5 cm beyond the nasolabial fold to the upper and lower lips. The atrophying orbicularis oris muscle and the site of insertion of the zygomaticus major and minor muscles into the orbicularis oris muscle are also exposed through this incision.

Through a 1.5-cm-long incision placed at the anterior margin of the parotid gland in the nonparalyzed cheek, several zygomatic and buccal branches of the intact facial nerve are exposed as the recipient nerve. This is confirmed by a nerve stimulator.

The harvested flap is trimmed and set into the recipient cheek pocket, with its anterior aspect oriented to meet the outer side. The proximal end of the flap (short head of the biceps femoris muscle and the attaching lateral intermuscular septum) is fixed to the nasolabial region of the upper and lower lips using nonabsorbable sutures. Microvascular anasto-

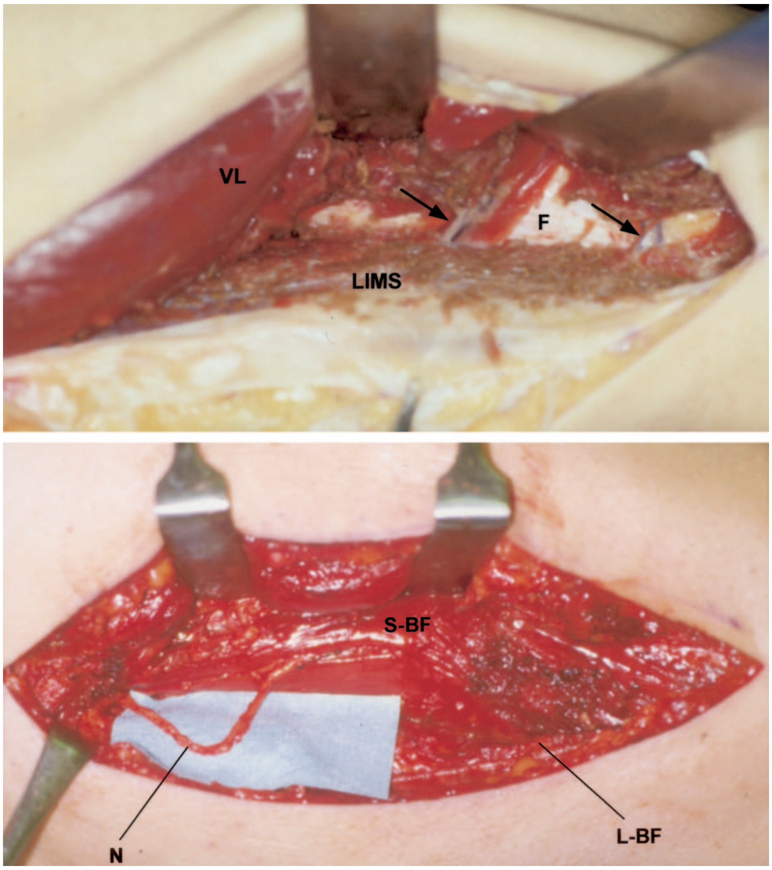


FIG. 6. Intraoperative views of the right thigh. The proximal side is to the left; the distal side is to the right. (*Above*) A longitudinal fascial incision just anterior to the junction of the lateral intermuscular septum (*LIMS*) to the fascia lata is made, and the muscle attachment of the vastus lateralis (*VL*) to the anterior surface of the lateral intermuscular septum is dissected to the femoral shaft (*F*). A series of perforating branches (*arrows*) can be identified penetrating the lateral intermuscular septum near the shaft of the femur to reach the vastus lateralis. (*Below*) A second fascial incision is made parallel and just posterior to the lateral intermuscular septum, and the biceps femoris muscle is exposed. The short head of the biceps femoris muscle is isolated by retracting the long head posteriorly. The motor nerve (*N*) of the short head can be easily identified at the lateral side of the muscle belly and can be easily dissected to reach the common peroneal division of the sciatic nerve. *S-BF*, short head of the biceps femoris muscle; *L-BF*, tendon of the long head.

moses are carried out between the profunda perforator vessels and the recipient facial artery and vein in an end-to-end fashion. The motor nerve of the short head is passed through the upper lip to the contralateral facial nerve branches. Epineural sutures between the motor nerve of the short head and one or two of the suitable facial nerve branches are accomplished under an operating microscope using 10-0 nylon sutures. Finally, the distal side of the flap is fixed to the zygoma using nonabsorbable sutures, giving proper tension to the transferred muscle and overcorrecting the deformity slightly (Fig. 8).

## RESULTS

A total of seven patients with facial paralysis were treated with this procedure. Patient ages ranged from 30 to 80 years. The etiology of facial paralysis was acoustic neuroma in four patients, Bell's palsy in two patients, and trauma in one patient. The duration of paralysis before surgery ranged from 5 months to 6 years. The period required for initial voluntary movement of the transferred muscles ranged from 4 to 10 months after operations. The period of postoperative follow-up ranged from 5 to 42 months. The dominant nutrient vessels

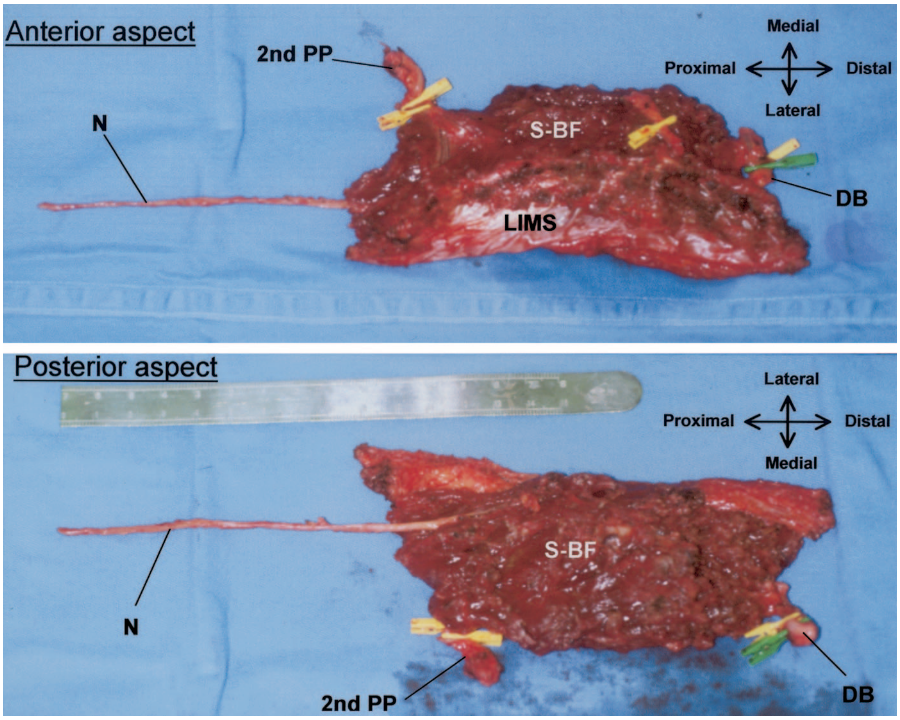


FIG. 7. Free neurovascularized short head of the biceps femoris muscle flap is harvested from the right thigh and viewed from anterior and posterior aspects. *LIMS*, lateral intermuscular septum; *N*, motor nerve; *DB*, direct branch from the popliteal artery; *S-BF*, short head of the biceps femoris muscle; *PP*, profunda perforator.

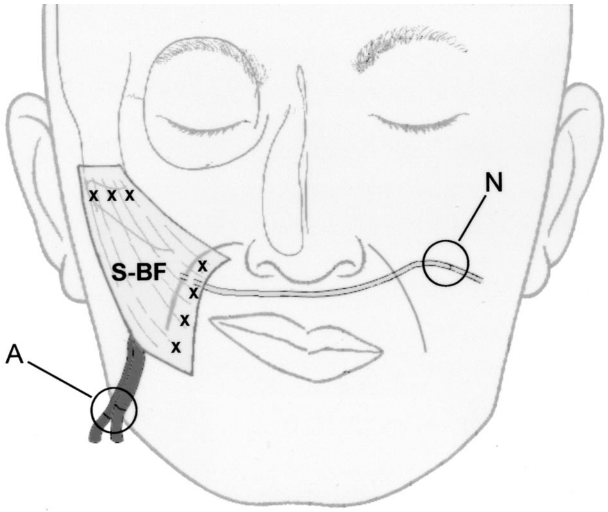


FIG. 8. Schema of one-stage reconstruction of a paralyzed face using the short head of the biceps femoris muscle. *A*, site of vascular anastomosis; *N*, site of nerve suture; *S-BF*, short head of the biceps femoris muscle.

of the short head of the biceps femoris muscle were the profunda perforators (second or third) in six patients and the direct branches from the popliteal vessels in one patient. The recipient vessels were the facial vessels in all patients. The length of the motor nerve of the short head of the biceps femoris ranged from 10 to 16 cm, and it was sutured directly to several zygomatic and buccal branches of the contralateral facial nerve in six. One patient required a 3-cm interpositional graft of the great auricular nerve to reach the suitable facial nerve branches on the intact side. Patient evaluation of facial reanimation showed excellent recovery in two, good in three, and fair in one among those with postoperative follow-up of more than 12 months (Table I).

## CASE REPORTS

### *Case 1*

A 55-year-old woman had undergone resection of a right acoustic neuroma involving the facial nerves and had right complete facial paralysis. She had severe facial asymmetry, eyebrow ptosis, inability to close her right eyelids, and difficulty in eating and drinking. One year after the surgery, a single-stage transfer of the short head of the biceps femoris muscle was carried out. Lifting of her right lower eyelid was performed simultaneously using a titanium anchor suture. Movement of the transferred muscle was first noticed 5 months after the transfer. Eight months after the transfer, she had good symmetry on rest and smiling (Fig. 9). The donor scar at the mid-lateral portion of her right lower thigh was inconspicuous and the contour of the donor site was quite acceptable, and she had no complaint of instability in her right knee while walking (Fig. 10). The manual muscle power test at 6 months postoperatively showed no difference between the right and left hamstring muscles. Electromyogra-

TABLE I
Patient Summary

| Patient | Age | Sex | Etiology | Dominant Flap Vessels | Recipient Vessels | Initial Movement after Operation (mo) | Follow-Up (mo) | Patient Evaluation |
|---|---|---|---|---|---|---|---|---|
| 1 | 55 | F | Acoustic neuroma | 2nd PP | Facial | 5 | 42 | Excellent |
| 2 | 44 | F | Acoustic neuroma | 3rd PP | Facial | 7 | 26 | Good |
| 3 | 59 | M | Bell's palsy | DB | Facial | 6 | 14* | Good |
| 4† | 30 | F | Trauma | 3rd PP | Facial | 10 | 23 | Good |
| 5 | 80 | F | Bell's palsy | 3rd PP | Facial | 8 | 22 | Fair |
| 6 | 69 | F | Acoustic neuroma | 3rd PP | Facial | 4 | 12 | Excellent |
| 7 | 62 | M | Acoustic neuroma | 2nd PP | Facial | 5 | 5 | – |

PP, profunda perforators; DB, direct branches from the popliteal vessels.
* Patient died of heart attack.
† Patient who underwent interpositional nerve graft.

FIG. 9. Case 1. A 55-year-old woman with complete right facial paralysis after resection of a right acoustic neuroma. (*Above*) Preoperative views: static (*left*), smiling (*center*), and closing (*right*) eyes. (*Below*) Postoperative views at 8 months: static (*left*), smiling (*center*), and closing (*right*) eyes. Natural symmetrical movements on smiling and closing eyes have been achieved.

FIG. 10. Postoperative views of the donor site at 8 months. The donor scar at midlateral portion of her right lower thigh is inconspicuous and contour of the donor site is quite acceptable. (*Left*) Lateral view. (*Right*) Anterior view.

phy at 10 months postoperatively showed high-amplitude spontaneous action potentials and evoked potentials upon stimulation of the contralateral facial nerve.

### *Case 2*

A 69-year-old woman had left complete facial paralysis caused by resection of a left acoustic tumor 2 years earlier. A free short head of the biceps femoris muscle with a long motor nerve was transferred to the paralyzed face. Lifting of her left lower eyelid was performed simultaneously using a titanium anchor suture. Postoperatively, initial contraction of the transferred muscle occurred 4 months after the operation. Six months after the transfer, she had good symmetry on rest and smiling (Fig. 11). The donor scar was acceptable, and no functional impairment in the donor leg was observed.

## DISCUSSION

The goals of rehabilitation of the paralyzed face should be the following: (1) normal appearance at rest; (2) symmetry of voluntary motion; (3) restoration of oral, nasal, and ocular sphincter control; (4) symmetry of involuntary motion and controlled balance in expressing emotion; and (5) no loss of other significant functions.[7] No single surgical technique can accomplish all of these goals. Recently, surgical procedures involving microsurgical dynamic muscle transplantation with facial nerve control innervation have been attempted to achieve these aims.[1–5,8–16] Among these procedures, the two-stage method is the most widely accepted method of treatment in cases of complete longstanding facial paralysis. The main disadvantage of the two-stage procedure is the delay of nearly 18 to 24 months before the results of reconstruction are apparent to the patient. The single-stage technique for cross-face reanimation of the paralyzed face without nerve graft is an improvement over current methods because it results in early reinnervation of the transferred muscle and shortens the period of rehabilitation.[2–5]

Koshima et al.[3] used the rectus femoris muscle and reported good results with a single-stage vascularized muscle transfer with a cross-face nerve graft. The rectus femoris muscle has a large arterial supply and long femoral nerve. The rectus femoris is bipennate, however, and tetanic force is lower in bipennate muscles than in parallel-fibered muscles when they are freely transferred with neurovascular repair.[5,17] Kumar[2] used gracilis and later reported a comparative study of the single-stage and two-stage procedures, saying that 50 percent of the patients who had single-stage reconstruction evaluated the results as excellent compared with only 15 percent of the two-stage patients, although the results of the two methods were comparable.[18] Harii et al. preferred to use the latissimus dorsi muscle because it can provide a sufficient length, more than 15 cm, of the mo-

FIG. 11. Case 2. A 69-year-old woman with complete left facial paralysis caused by resection of an acoustic neuroma. (*Above*) Preoperative views: static (*left*), smiling (*center*), and closing (*right*) eyes. (*Below*) Postoperative views at 11 months: static (*left*), smiling (*center*), and closing (*right*) eyes. Symmetrical balance and good facial tone at rest and natural movement on smiling have been achieved.

tor nerve with a long and sizable nutrient vessel pedicle.[5,19]

The biceps femoris muscle occupies a posterolateral position in the thigh and has two proximal attachments: the long head and the short head. The short head of the biceps femoris arises from the lateral lip of the linea aspera between the adductor magnus and vastus lateralis; the attachment extends proximally almost to the gluteus maximus and distally along the lateral supracondylar line to within 5 cm of the lateral femoral condyle and from the lateral intermuscular septum. The muscle fibers of the short head join the tendon of the long head to form the heavy round tendon that forms the lateral margin of the popliteal fossa and is attached mostly to the head of the fibula. The proximal and central parts of the short head are supplied by the second to fourth perforating arteries (the fourth perforating artery may be absent and a direct branch from the popliteal artery may enter the muscle instead), and the distal part is supplied by the superior and inferior lateral genicular arteries. The two heads are differently innervated; the nerve to the short head is a branch of the common peroneal division of the sciatic nerve (L5; S1, 2), which enters the superficial surface of the muscle.[20–22] Despite these descriptions in anatomy textbooks, the short head of the biceps femoris has not previously been considered as reconstructive material for neurovascularized free tissue transfer. In our previous study highlighting the anatomical features of the lateral intermuscular septum and the short head of the biceps femoris, we suggested that a free short head of the biceps femoris muscle flap based on the profunda femoris perforating vessels would be useful in functional reconstruction such as reanimation of the paralyzed face.[6] Harvest of the muscle flap is performed in a supine position with a pillow inserted under the buttock of the affected side, allowing two operating teams to work simultaneously without the need to reposition the patient. A tourniquet is not used to harvest the donor muscle because accurate dissection of anatomical layers causes minimal blood loss and sometimes the surgeon can feel the palpitations of the profunda perforators to locate them. Furthermore, a tourniquet may be obstructive when intraneural dissection of the motor nerve of the short head is needed. After dissecting the vastus lateralis muscle from the anterior surface of the lateral intermuscular septum, a series of perforating branches can be identified penetrating the lateral intermuscular septum near the shaft of the femur to reach the vastus lateralis. These are branches from the first to third profunda perforators and the superior lateral genicular artery or direct branch from the popliteal artery. The dominant nutrient vessels of the short head can be estimated by identifying the largest one among these perforating branches. In this preliminary clinical series applying the short head to reanimation of facial paralysis, the dominant nutrient vessels of the short head were the profunda perforators (second or third) in six patients and the direct branches from the popliteal vessels in one patient, and vessels were sizable in all cases. The recipient vessels were the facial vessels in all cases; however, superficial temporal vessels may be preferable recipient vessels for direct branches from the popliteal vessels and the superior lateral genicular vessels. The motor nerve of the short head is a branch of the common peroneal division of the sciatic nerve and runs mostly superficially to it, so a further 3 to 5 cm of the motor nerve can easily be gained by intraneural dissection. This procedure dose not injure motor nerves of the other hamstring muscles because both motor nerves of the long head of the biceps femoris and the medial hamstring arise from the tibial component of the sciatic nerve.[20–22] The motor nerve of the short head was long enough to reach the facial nerve branches, except in one patient who required an interpositional nerve graft. This patient was only 140 cm in height. The length of the motor nerve of the short head is estimated to be proportional to the length of the thigh, so an interpositional nerve graft should be considered in adults of short stature.

Regarding donor site morbidity in harvesting the short head of the biceps femoris muscle, functional loss of the biceps femoris as a lateral knee stabilizer and knee flexor is not noticeable if the adjacent muscles are undisturbed.[23] In our clinical series, no patients complained of instability in the donor knee while walking or in their activities of daily life. The donor scar at the mid-lateral portion of the lower thigh and the contour of the donor site were quite acceptable in all patients. Because both nutrient vessels and motor nerve of the short head run through the mid-layer of the muscle, reduction of the muscle in situ to obtain an appropriate thickness can be performed safely. The removed segment of the muscle is concealed within the donor site; this will be helpful to restore the contour of the distal portion of the lateral thigh.

Transfer of the vascularized innervated short head of the biceps femoris muscle is suitable as an alternative for one-stage reconstruction of the paralyzed face because of the reliable vascular anatomy of the muscle and because it allows two teams to operate together without the need to reposition the patient. The nerve to the short head of the biceps femoris enters from the opposite side of the vascular pedicle of the muscle belly, and this unique relationship between the vascular pedicle and the motor nerve is anatomically suitable for one-stage reconstruction of the paralyzed face. Up to 16 cm of the nerve can be harvested, and the nerve is long enough to reach the contralateral intact facial nerve in almost all cases. The lateral intermuscular septum, attached to the short head, provides "anchor/suture-bearing" tissue, allowing reliable fixations to the zygoma and to the upper and lower lips. In addition, the scar and deformity of the donor site are acceptable and loss of this muscle does not result in donor-site dysfunction.

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