A comparison of the donor-site morbidity after using the prelaminated fasciomucosal flap and the fasciocutaneous radial forearm flap for intraoral reconstruction

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SUMMARY. Since 1996 we have performed mucosal prelamination of the distal radial forearm flap for functional reconstruction of defects of the intraoral lining. This study was undertaken to demonstrate that the prelaminated fasciomucosal radial forearm flap can provide physiological oropharyngeal reconstruction with mucus-producing tissue, while avoiding the donor-site complications of the fasciocutaneous radial forearm flap. We examined the donor hand at least 6 months postoperatively in 20 patients after using a prelaminated fasciomucosal radial forearm flap and in 15 patients after harvesting a classical fasciocutaneous radial forearm flap. The evaluation of hand function included range of motion, grip power, pinch power, sensibility and vascular analysis in both hands. The patients were asked about cold intolerance, pain and any restrictions in daily life, and the cosmetic appearance of the donor hand was noted. In the prelaminated-flap group (n = 20), two patients had decreased wrist extension, and one of these patients also had reduced strength and mild hypaesthesia in the donor hand. In the classical-fasciocutaneous-flap group (n = 15), six patients had decreased wrist extension, five patients had reduced strength and four patients had diminished sensibility in the donor hand. Painful neuromas were found only after fasciocutaneous flaps (three cases). Subjective assessment revealed restricted hand function in one patient in the prelaminated-flap group, and in five patients who had undergone fasciocutaneous flap transfer. The results of this study show that using the prelaminated fasciomucosal radial forearm flap minimises the donor-site morbidity. Furthermore, we were able to improve the cosmetic appearance of this very exposed region. © 2002 The British Association of Plastic Surgeons

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The free radial forearm flap is a reliable and popular method for reconstructing defects of the intraoral lining, being a thin pliable flap with a long vascular pedicle. However, when using this flap, the intraoral mucosa is reconstructed with a skin island, which has a different colour and appearance from the neighbouring mucosa, may bear hairs, desquamates and does not produce mucus. Another major disadvantage of the radial forearm flap is the donor-site morbidity. Besides delayed healing and pain, there have been reports of functional deficits, including a reduced range of motion, decreased strength and dysaesthesia in the donor hand.

Flap prelamination has extended our reconstructive possibilities. Using this method, we have successfully prelaminated the distal radial forearm with buccal mucosa in patients with squamous cell carcinoma of the oral cavity. Thus, we have been able to achieve a physiological reconstruction of mucosal defects with mucus-producing tissue. In addition, preservation of skin and subcutaneous tissue enables primary closure of the distal forearm, so that flexor tendons, the superficial radial nerve and the median nerve are covered with a stable non-adherent tissue. Therefore, we expect a decrease in the donor-site morbidity. To evaluate this, we examined the donor hands of our patients after harvesting prelaminated fasciomucosal radial forearm flaps. The results were compared with those from a group of patients in whom we had used the classical fasciocutaneous radial forearm flap for intraoral reconstruction.

Patients and methods

Operative procedure

In the first operation, mucosal prelamination, marking of the tumour margins and dental restoration were performed. Using a distal transverse incision extended to the radial side of the forearm, skin and subcutaneous tissue were raised off the forearm fascia. Then, mucosal grafts were sutured onto the distal forearm fascia and covered with a silastic sheet the size of the future flap to avoid adhesions and to enable mucosal spreading. After insertion of a suction drain, the wound was closed primarily. The limb was immobilised for 1 week. In the following weeks the patients underwent radiotherapy and chemotherapy of their intraoral tumour. Radical tumour resection and primary reconstruction were carried out 8–10 weeks later using a two-team approach. The
prelaminated fasciomucosal flap was harvested in the traditional way, supplied by the radial artery and veins. Skin and subcutaneous tissue were preserved, enabling primary closure of the donor site. Again, a suction drain was inserted, and the limb was immobilised for 1 week using dorsal splinting. No specific hand therapy was used.

After harvesting a classical fasciocutaneous radial forearm flap, the flexor carpi radialis tendon was covered with neighbouring vascularised tissue to enhance the take of the skin graft, and the superficial radial nerve was strictly preserved. In these patients the donor-site defect was closed using a split-thickness skin graft, and the limb was also immobilised for 1 week using dorsal splinting. Again, no specific physiotherapy was performed.

All flap procedures were performed by the same surgeon. All flaps were raised from the non-dominant hand, except in one woman who had a negative Allen test in her left hand. The radial artery was never reconstructed.

**Patients**

Between March 1996 and September 1999, the senior author performed mucosal prelamination of the distal radial forearm in 24 patients with squamous cell carcinoma of the oral cavity or oropharynx, a classical fasciocutaneous distal radial forearm flap was used. Wound healing was documented postoperatively. The criterion for successful wound healing was a dry wound no longer requiring dressings. All patients were invited to participate in the follow-up study postoperatively. The two groups were comparable in terms of age at the time of examination, sex and length of follow-up (Table 1). Between March 1996 and September 1999, the senior surgeon performed mucosal prelamination of the distal radial forearm in 24 patients with squamous cell carcinoma of the oral cavity or oropharynx, a classical fasciocutaneous distal radial forearm flap was used. Wound healing was documented postoperatively. The criterion for successful wound healing was a dry wound no longer requiring dressings. All patients were invited to participate in the follow-up study postoperatively. The two groups were comparable in terms of age at the time of examination, sex and length of follow-up (Table 1).

**Examination of donor-site morbidity**

The functional examination was carried out in both hands. The ranges of motion of the wrist and digital joints were noted. Grip power and pulp-to-pulp pinch power (thumb against index finger) were measured quantitatively, using dynamometers, three times for each hand. The best value was recorded, and the results were compared against the expected 15% diminution of power in the non-dominant as opposed to the dominant hand. Sensibility was tested in the median and radial nerve regions using Semmes–Weinstein monofilaments. Vascular analysis was performed using digital photoplethysmography on both index fingers (Periquant 3800 Gutmann Medizinelektronik) and computed infrared thermography on the second and fifth fingers and the thenar region in both hands (Agema Infrared System, Thermovision 900). In the subjective assessment, patients were asked about pain, cold intolerance and any restrictions of hand function on daily life. Each donor site was photographed, and the patients were asked their opinion of the cosmetic result.

Statistical analysis was performed using the paired Student’s t-test; values less than 0.05 were regarded as statistically significant.

**Results**

**Wound healing**

After harvesting the fasciomucosal prelaminated flaps, the donor sites could be closed without tension, and healed uneventfully in all patients. The dressings and sutures were removed 10 days postoperatively.

Following the harvest of classical fasciocutaneous flaps, the donor sites healed within 2 weeks in 13 patients. In two patients there was a partial loss of the skin graft, which involved 10% and 20%, respectively, of the graft. These patients underwent splitting for 10 days. Though flexor tendons were not exposed, wound healing was delayed to 4 and 6 weeks without secondary surgical intervention.

**Range of motion**

Compared with the normal untreated hand, the range of motion of the digital joints as well as wrist flexion, radial and ulnar deviation, pronation and supination were unimpaired in all patients in both groups. Decreased wrist extension (>5° decrease compared with the normal hand) was found in two of the 20 patients who had undergone prelaminated flaps, and in six of the 15 patients who had undergone classical fasciocutaneous flaps (Table 2).

**Table 2** Results of the functional examination and subjective assessment of the donor hand (compared with the contralateral unoperated hand) after raising either a prelaminated fasciomucosal flap or a classical fasciocutaneous radial forearm flap (values are numbers of patients)

<table>
<thead>
<tr>
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<th>Fasciomucosal flap (n = 20)</th>
<th>Fasciocutaneous flap (n = 15)</th>
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<tr>
<td>functional examination</td>
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<tr>
<td>decrease of wrist extension</td>
<td>2</td>
<td>6</td>
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<td>decrease of grip power</td>
<td>1</td>
<td>4</td>
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<td>decrease of pinch power</td>
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<td>5</td>
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<tr>
<td>hypaesthesia of the median nerve region</td>
<td>1</td>
<td>2</td>
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<tr>
<td>hypaesthesia of the radial nerve region</td>
<td>0</td>
<td>4</td>
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<tr>
<td>subjective assessment</td>
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<tr>
<td>cold intolerance</td>
<td>1</td>
<td>2</td>
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<tr>
<td>painful neurama</td>
<td>0</td>
<td>3</td>
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<tr>
<td>restricted function in daily life</td>
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Strength

A decrease in the strength of the donor hand (more than 15% below the contralateral untreated hand) was found in one of the 20 patients who had had a prelaminated flap, and in five of the 15 patients who had had classical fasciocutaneous flaps (Table 2). In the prelaminated-flap group the donor hand had, on average, 92% of the grip power and 86% of the pulp-to-pulp pinch power of the unoperated hand; this difference represents the normal difference between non-dominant and dominant limbs (Fig. 1A). In the classical-fasciocutaneous-flap group the donor hand had, on average, 72% of the grip power and 65% of the pulp-to-pulp pinch power of the contralateral hand (Fig. 1B). The differences between the groups were statistically significant in terms of both grip power and pinch power.

Sensibility

In the prelaminated-flap group (n=20) one patient had reduced sensibility in the first, second and third fingertips of the donor hand compared with the contralateral hand, as assessed using the Semmes–Weinstein monofilaments. In the classical-fasciocutaneous-flap group (n=15) we found reduced sensibility in the donor hands of four patients. Two of them had hypaesthesia in the radial nerve region only, and the other two had reduced sensation in the radial and median nerve regions. In all patients who showed diminished sensibility in the donor hand, the difference between the donor hand and the unoperated hand was either two or three filaments.

Vascular analysis

Vascular analysis and thermography showed no relevant differences between patients who had had prelaminated fasciomucosal flaps (n=8) and those who had had classical fasciocutaneous flaps (n=5). Therefore, these investigations were not performed in the remaining patients.

Rheography showed a 4–28 ms (mean: 10 ms) delay of the pulse wave in 10 of the above 13 patients in the operated hand compared with the contralateral side. In three patients we also found a 4 ms delay in the unoperated hand. At room temperature, digital photoplethysmography showed reduced perfusion (<20%) in three of the 13 patients, equal perfusion in eight patients and better perfusion (>20%) in two patients in the operated hand compared with the unoperated side. Infrared thermography showed that six out of the 13 patients already had abnormally reduced baseline temperature values (<31.5 °C) in both hands. The mean difference in baseline temperature values between the hands was 0.1 °C. A difference of more than 0.5 °C between the hands was regarded as abnormal. In three of the 13 patients the donor hand was colder (mean: −1.6 °C) and in three patients it was warmer (mean: +1.5 °C) than the unoperated hand. Seven patients had equal temperatures in both hands.

Subjective assessment

In the prelaminated-fasciomucosal-flap group (n=20) only one patient complained of cold intolerance. This patient also had reduced sensibility in the median nerve region and, therefore, restricted hand function in daily life. None of these patients had pain in the donor hand, and all were satisfied with the cosmetic result (Table 2 and Fig. 2A,B).

In the classical-fasciocutaneous-flap group (n=15) two patients had cold intolerance and three patients had painful neuromas of the superficial radial nerve. They also complained of diminished sensibility and reduced strength in the donor hand. These five patients felt that they had restricted hand function in daily life (Table 2). One of these patients had severe problems because the donor site was on her right dominant hand, due to a negative Allen test on the left. Eight of the 15 patients in the fasciocutaneous-flap group were dissatisfied with the cosmetic appearance (Fig. 3A,B).

Discussion

First described by Soutar et al in 1983, the fasciocutaneous radial forearm flap remains the most frequently

Figure 1—Grip power and pinch power in the donor hand and unoperated (control) hand: (A) prelaminated-fasciomucosal-flap group; and (B) classical-fasciocutaneous-flap group. The open bars represent the control hand and the filled bars represent the donor hand.
used flap for intraoral reconstruction. Nevertheless, a major disadvantage of this flap is its significant donor-site morbidity. The donor-site defect is usually covered with a split-thickness skin graft, resulting in an obvious donor site. Moreover, functional deficits of the donor hand have been reported. As shown in the literature, functional donor-site complications can be minimised by suprafascial dissection of the radial forearm flap. However, this technique still requires a skin graft, which leaves a visible donor-site defect in this aesthetically exposed region. Moreover, defects of the intraoral lining are reconstructed using skin of a different texture, colour and appearance to mucosa. Using the prelaminated fasciomucosal radial forearm flap we have been able to improve greatly the functional and cosmetic results at the recipient site as well as in the donor hand.

In our series, only two out of 20 patients had a slightly reduced range of wrist motion after the harvesting of prelaminated flaps. One of these patients also had diminished sensation and reduced strength in the donor hand. In 1996, Suominen et al reported a correlation between sensory deficits and weak grip strength following radial-forearm-flap harvest. In the fasciocutaneous-radial-forearm-flap group there was a higher incidence of functional deficits in the donor hands. High incidences of reduced sensation (32%–71%) and pain (3%–34%) following radial-forearm-flap harvest have also been reported in the literature. In our study, painful neuromas occurred only after the harvest of classical fasciocutaneous flaps, and two of these three patients had delayed healing due to partial loss of the skin graft. As the superficial radial nerve was carefully separated and preserved intraoperatively in all cases, it is likely that shrinking of the skin graft led to sensory disturbances.

Cold intolerance is a common complaint after raising a radial forearm flap; its incidence ranges from 8% to 40%. In our study, three patients reported cold intolerance in the donor hand. These patients also had diminished sensibility in the median nerve region and reduced temperatures on infrared thermography. There was no correlation between subjective cold intolerance and reduced hand perfusion as measured by plethysmography. Thus, cold intolerance does not seem to have a vascular cause, but could result from disturbances in the sympathetic nervous system.

Several authors have used temperature measurements to assess vascular changes after raising a radial forearm flap. In 1993, Meland et al found no differences between the donor hand and the unoperated side. In 1996, Suominen and Ask-Seljavaara found a difference of more than 0.5°C in 44% of their patients. There is no study that used both photoplethysmography and thermography to assess the effects of raising a radial forearm flap.

In our study, vascular analysis and thermography showed...
no differences between patients who had prelaminated fasciocutaneous flaps and those who had classical fasciocutaneous flaps. This seems reasonable, since in both groups the radial artery was removed and not reconstructed. Using rheography, we saw a delay of the pulse inflow, which now comes from the opposite side of the palmar arch because of the loss of the radial artery. Though blood flow is known to be correlated with skin temperature, in our study the results of plethysmography, and therefore the circulation of the hand, were not correlated with the thermography. Interestingly, nearly half the patients had reduced baseline temperatures in both hands. This may be explained by their oncologic disease, chemotherapy, radiotherapy or smoking habits. We also found that three of the 15 patients had higher temperatures in the donor hand than in the unoperated hand. These findings confirm those of the study by Suominen and Asko-Seljavaara, who found a warmer donor hand in 22% of patients after raising a radial forearm flap.15

Photographs showed that the cosmetic results were clearly better after raising a prelaminated fasciocutaneous flap than after raising a classical fasciocutaneous flap. The closure of the donor site by skin grafting often results in delayed healing and contour defects of the donor limb. As shown in the literature, 17%-29% of patients are unhappy with the cosmetic results after fasciocutaneous-forearm-flap harvest.3,18 In our study, eight out of 15 patients who had had fasciocutaneous flaps were dissatisfied with the cosmetic appearance, whereas all the patients who had had prelaminated flaps were satisfied with the cosmetic result.

We have shown that mucosal prelamination of the distal radial forearm flap can significantly improve the functional result in the donor hand. Preserving skin and subcutaneous tissue enables direct closure of the donor site. Thus, the risk of producing painful neuromas is minimised, contour defects can be avoided and the cosmetic appearance of the donor limb is greatly improved.

References

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