ULNAR VERSUS RADIAL FOREARM FLAP IN HEAD AND NECK RECONSTRUCTION: AN EXPERIMENTAL AND CLINICAL STUDY

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Abstract: *Background.* To consider the pros and cons of the microvascular ulnar forearm flap compared with its radial counterpart, this study compares the use of these two flaps for head and neck reconstruction.

Methods. In 75 patients, 51 ulnar and 24 radial forearm flaps were used. Both groups were compared regarding flap dissection, suitability of the flap for the recipient region, complication rate, and secondary morbidity in the donor region. Furthermore, in 40 healthy volunteers, the thickness of the subcutaneous tissue layer was measured by use of ultrasonography.

Results. Flap survival rate, respectively wound healing, in the recipient region showed no differences. Clinical and experimental results demonstrated a thinner subcutaneous layer in the ulnar aspect of the forearm. Compared with its radial equivalent, closure of the ulnar donor side by skin grafting resulted in a significantly lower complication rate.

Conclusions. The ulnar forearm flap is favored because of the less hairy skin of the ulnar forearm region, the thinner layer of subcutaneous tissues, and the more conveniently located donor area. The ulnar forearm pedicle is long compared with alternative transplants but shorter than the radial equivalent. © 2001 John Wiley & Sons, Inc. *Head Neck* **23:** 967–971, 2001.

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Despite the popularity of the radial forearm flap in head and neck reconstruction—mainly for historical reasons—the use of the ulnar forearm flap is less widespread.

The ulnar forearm flap was first described by Lovie et al from Wellington in 1984, 2 years after its radial counterpart had been introduced clinically.[1] Maybe the pretense of a more difficult dissection and a more unreliable vascularization has resulted in just a few reports about its clinical use.

Nevertheless, there are some advantages that make the ulnar forearm flap preferable in contrast to other fasciocutaneous flaps and to the radial forearm flap for reconstructive procedures in this region.[2,3]

To consider the pros and cons of the microvascular ulnar forearm flap contrary to its radial equivalent, this study compares the use of these two flaps for head and neck reconstruction clinically.

As in reconstructive procedures for this region, in most cases fasciocutaneous flaps need to be as thin as possible; in an experimental study, the thickness of the subcutaneous layer was de-

termined in the ulnar and radial aspect of the forearm by ultrasonography.

MATERIALS AND METHODS

Patient Data and Surgical Technique. Fifty-one ulnar and 24 radial forearm flaps were used for reconstructive procedures in 75 patients (30 women, 45 men; age, 21–86 years). All operations were performed by the same surgeon (PS). This series was carried out in a more or less sequential fashion, starting exclusively with radial forearm flaps and changing over time to the ulnar forearm flaps without any specific selection of cases for one of the flaps being used. In 69 patients, the reconstructive procedure was carried out immediately after ablative surgery, 6 patients were reconstructed secondarily. In three patients, an osteocutaneous radialis forearm flap was used for simultaneous mandible reconstruction. Three adipofascial flaps were raised from the radial aspect of the forearm for soft tissue augmentation in cases of Romberg disease. Two ulnar forearm flaps were prepared including flexor carpi ulnaris muscle for musculocutaneous transfer.

The Allen test was the only mandatory test used preoperatively to exclude cases of advanced stages of arteriosclerosis or vascular anomalies that may prohibit sacrifice of one of the two big arteries serving forearm and hand.

Flap dissection followed the original descriptions.[1,4,5] A tourniquet was used for bloodless preparation. The deep venous system was used for venous drainage of the flaps by anastomosing one of the venae comitantes accompanying radial or ulnar artery (Figs. 1 and 2).

Primary closure of the skin defect of the donor region was attained when flaps as wide as 4 cm were taken, otherwise closure was accomplished using abdominal or inguinal full-thickness skin grafts. In the latter case, the wrist joint was immobilized for 2 weeks by plaster slab.

Both groups were compared regarding flap dissection, suitability of the flap for the recipient region, complication rate, and secondary morbidity in the donor region.

Experimental Approach. In 40 healthy volunteers (20 women, 20 men; age, 24–78 years) the thickness of the subcutaneous tissue layer was measured by ultrasonography (10 MHz). The ultrasound probe was placed above radial and ulnar artery at the distal third of the forearm and more proximal at the junction of the distal and middle third (Fig. 3). In each of these four positions, five measurements of the thickness of the subcutaneous fatty layer were carried out. For statistical analysis, the *t* test was used for comparing radial and ulnar side at both levels, as well as for comparing distal and proximal measurement of each side.

Clinical Results. Flap survival rate, respectively wound healing, in the recipient region showed no differences (Table 1). However compared with its radial equivalent, closure of the ulnar donor side by skin grafting resulted in a significantly lower complication rate (Table 2).

Short-term symptoms of sensory disturbances (digitus III–V) were seen in a few patients after ulnar forearm flap preparation. Permanent sensory disturbances were limited to the innervation

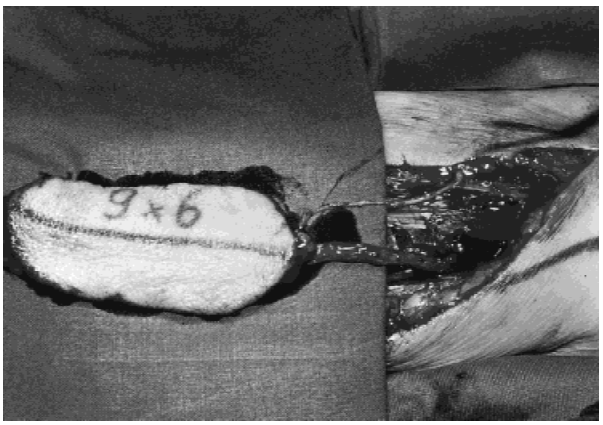

FIGURE 1. Ulnar forearm flap prepared with vascular pedicle and Ramus cutaneous medialis (above the pedicle) for sensory reinnervation.

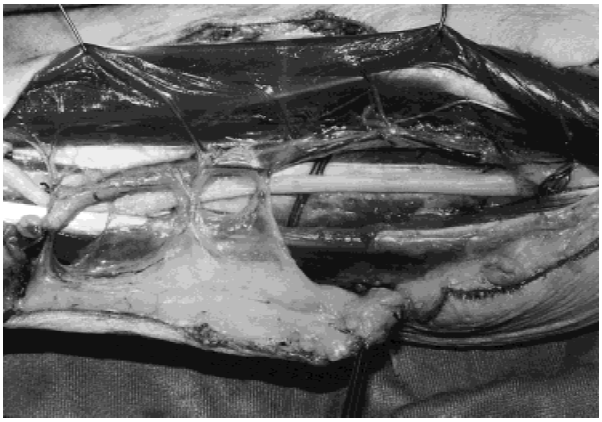

FIGURE 2. Ulnar forearm flap with three perforators in the middle and distal third of the forearm. The medial muscle septum is thinner compared with the lateral one at the radial aspect. (Ulnar nerve below the vascular bundle.)

Table 1. Postoperative complications in the recipient region.

	Radial forearm flap	Ulnar forearm flap
No. of flaps	24	51
Size (in cm)	3.5 × 4.0–6.0 × 11.0	3.5 × 5.0–6.5 × 10.0
Loss of flaps	1	1
Minor wound healing disturbances	1	3

area of the median or lateral cutaneous nerve of the forearm. No motor disturbances occurred after forearm flap transfer.

Experimental Results. Table 3 presents the thickness of the subcutaneous layer measured by ultrasonography. Each average value represents 400 measurements (5 measurements in each position in 80 forearms of 40 volunteers). In this series, the fatty layer was significantly thinner in the ulnar side of the forearm and in the more distal measurement ($p \leq .05$).

DISCUSSION

Two principles guide us in the selection of the flap for soft tissue reconstruction in the head and neck region using free microvascular flaps: in most cases, defects are thin; therefore, a bulky flap is not suitable. Furthermore, we prefer, whenever possible, a donor region that permits simultaneous resection and harvest.

Under these premises, the lateral upper arm flap, the groin flap, the dorsalis pedis flap, and the vastus lateralis flap have to be considered alternatively to the forearm flaps.

The lateral upper arm flap has become more popular within the last few years.[6–8] Its secondary defect can be closed directly in most cases, and no artery of the forearm has to be sacrificed. On the other hand, its pedicle is thin and short compared with the one of forearm flaps.

The dorsalis pedis flap is very thin, but its donor region is not a very forgiving area, resulting in an unacceptably high secondary morbidity.[9]

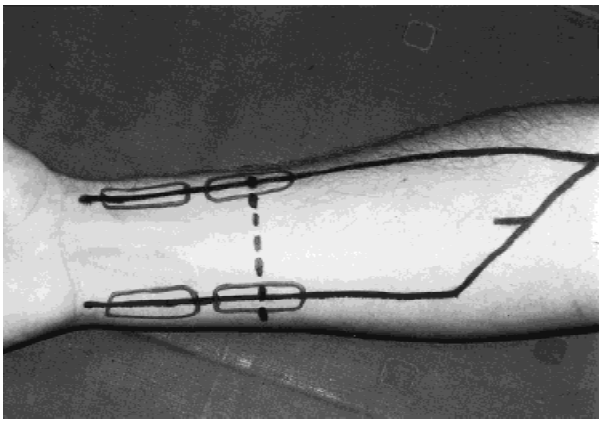

FIGURE 3. Forearm with marked four positions of the ultrasound probe for measurement of the thickness of the subcutaneous fatty layer (dotted line, border between distal and medial third of the forearm).

The vastus lateralis flap applied as myocutaneous or fasciovascular transplant is useful for coverage of more extensive defects. Flap transfer is facilitated and accelerated by the long and high-caliber vascular pedicle, and donor site morbidity is very low. As a disadvantage, the often very thick subcutaneous fatty layer has to be considered.[10,11]

Comparing radial and ulnar forearm flap, differences could be detected in the suitability for the recipient region and regarding the donor site morbidity.

After becoming familiar with the anatomic area, flap dissection required the same amount of time on both sides. In the ulnar aspect of the forearm, the ulnar nerve has to be separated from the vascular bundle, which can be dissected proximally up to the takeoff of the common interosseous artery, resulting in an approximately 4 cm shorter vascular pedicle of the ulnar forearm flap. The radial and ulnar artery have the same average diameter of 2.5 mm, which is suitable for anastomosing to branches of the external carotid. No differences could be seen between the venae comitantes. Because both the superficial and deep

Table 2. Postoperative complications in the donor region.

	Radial forearm flap	Ulnar forearm flap
No. of flaps	24	51
Effusion after mobilization of wrist joint	8	—
Dehiscence	5	4
Partial loss of skin graft	2	—

Table 3. Thickness of the subcutaneous fatty layer of the forearm (in mm) at the distal and proximal level of measurement (details see test).

	Ulnar	Radial
Distal	2.6 ± 0.9	2.9 ± 1.0
Proximal	3.2 ± 1.2	3.6 ± 1.2

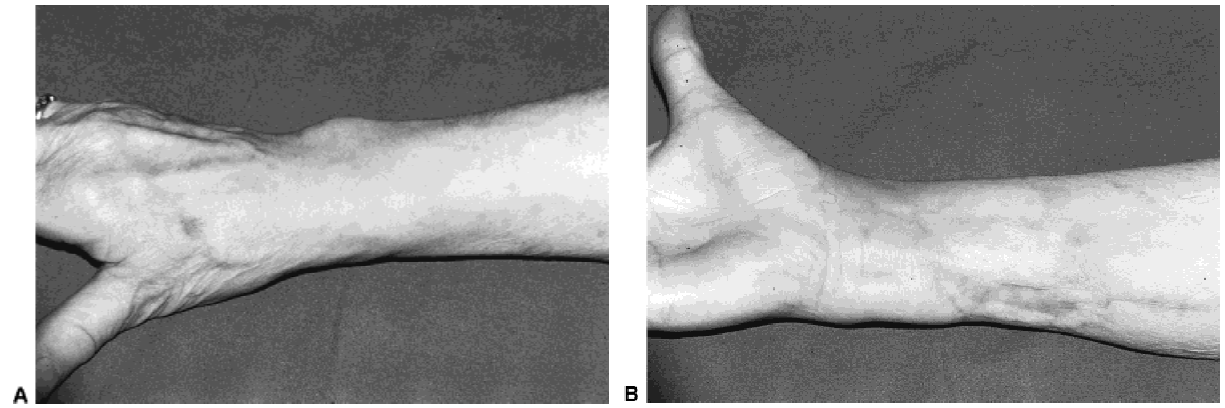

FIGURE 4. (A, B) Right forearm 3 months after harvesting ulnar forearm flap. Please note the donor area covered by full-thickness skin graft at the rarely exposed ulnar aspect.

venous systems are equally capable of draining forearm flaps, the cephalic or the basilic vein may be used alternatively. Their large caliber lends itself to easy anastomosis, whereas the venae comitantes are sometimes very small in diameter.

In both flaps, sensory reinnervation is possible by anastomosis of cutaneous sensory branches (ramus cutaneus medialis et lateralis) to sensory nerves in the recipient region (Fig. 1).[12–14]

Both flaps are popular in head and neck reconstruction, because they are considered to be thin in contrast to alternative flaps. Our experimental results confirmed the clinical impression of a slightly thinner fatty layer in the ulnar aspect of the forearm in the distal third and more proximal in the forearm, even if the experimentally determined difference of 0.3 to 0.4 mm may not be clinically significant.

In our clinical series, four radial forearm flaps were transferred as osteocutaneous flaps. For both flaps, an osteocutaneous transfer is described using segments of radius or ulna.[12]

Because of the small bone stock, the osteocutaneous radial forearm flap is considered to be a "second choice option"; it is hard to find an argument to carry out bone transfer from the ulnar side with an even smaller bone segment that can be removed.

The less hairy skin in the ulnar aspect of the forearm, especially in most of the male patients, favors the ulnar forearm flap, particularly for intraoral and pharyngeal reconstruction.

The noticeable donor area of the forearm flaps is rated as a disadvantage in contrast to alternative flaps.[12,15] The more concealed donor area in the medial (ulnar) region is better accepted, especially by women, in contrast to the difficult to camouflage donor region located at the radial (lateral) aspect of the forearm with a noticeable skin graft, which is often under the surrounding skin level (Fig. 4).

Furthermore, even if the flap is harvested from the distal third of the forearm, after ulnar forearm flap transfer, muscles form the surface of the donor defect (m flexor carpi ulnaris, m flexor digitorum superficialis) instead of exposed tendons in the radial donor site. This explains the lower complication rate in the ulnar side after skin grafting of the donor defect.

Summarizing the differences between these two flaps for soft tissue reconstruction in the head and neck region, we prefer the ulnar forearm flap because of less hair-bearing skin of the ulnar forearm region, which favors the ulnar forearm flap, especially for intraoral and pharyngeal soft tissue replacement. Furthermore, the more conveniently located donor area results in a better camouflage of the donor site and fewer donor site complications. The ulnar forearm pedicle is long compared with alternative transplants but shorter than the radial equivalent.

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