Abstract: Background. Superficial ulnar artery is a well-known vascular anomaly that may cause special risks because of possible impairment of the vessel by mistake during harvesting fasciocutaneous forearm flaps.

Methods. The charts of patients who had undergone forearm flap transfer were reviewed for vascular anomalies. When a superficial ulnar artery was present, a superficial ulnar artery flap was raised and arteriography was performed postoperatively to figure out the vascular pattern in the contralateral arm.

Results. Four superficial ulnar arteries were found during dissection of ulnar forearm flaps (n = 107). We were unable to identify any superficial ulnar artery when preparing the radial pendant (n = 27), and we did not notice any impairment of such an artery. The four superficial ulnar artery flaps healed uneventfully. Postoperative arteriography revealed a bilateral vascular anomaly in one of the four cases.

Conclusion. The superficial ulnar artery is a calculable anatomical variation as long as its possible presence is considered during flap harvesting. In these cases, the use of the superficial ulnar artery flap was found to be an easy and safe alternative.

Keywords: forearm flap; superficial ulnar artery; microsurgery; vascular anomaly; reconstructive surgery

Although most of the anomalous patterns of upper limb arterial vascular anatomy cause no functional consequences, some variations are of considerable interest to surgeons as well as to vascular radiologists.

The most frequent anomaly described in numerous cadaver and clinical studies is an unusually high origin of the radial artery from the brachial artery, followed by the superficial ulnar artery.1–3

The latter is characterized by the presence of the so-called superficial ulnar artery, which replaces the normal ulnar artery. The incidence has been reported to be 0.7% to 9.38% of cases according to authors.2,4,5 Although unilateral presence of this anomaly is not often found, bilateral cases of a superficial ulnar artery are observed even more seldom.6,7

The common ulnar artery arises distal to the crook of the elbow as the larger of the two terminal divisions of the brachial artery. It runs in the forearm beneath the antebrachial flexor muscles accompanying the ulnar nerve and passes the wrist superficial to the flexor retinaculum.

The superficial ulnar artery originates from the brachial or, more rarely, from the axillary artery (Figure 1). Along the forearm it passes superficial...
to the pronator teres and flexor muscles. It can lie deep or superficial to the fascia covering these muscles. The palmaris longus muscle is described as being absent in some of these cases. Like the common ulnar artery, the superficial ulnar artery establishes the superficial palmar arch in the hand with a contribution from the superficial branch of the radial artery.

With use of the forearm as a donor region for harvesting microvascular soft tissue flaps, the presence of a superficial ulnar artery may involve special risks because of possible impairment of the vessel by mistake. On the other hand, it may provide additional options for preparing flaps with these vessels as arterial paddles.

**PATIENTS AND METHODS**

The microvascular reconstructive database of our department was queried for all patients undergoing fasciocutaneous free flap reconstruction. Patients with free tissue transfer using the forearm as donor region were identified.

Within the past 10 years, 107 ulnar forearm flaps (30 in women and 77 in men) and 27 radial forearm flaps (16 in woman and 11 in men) were used in our institution for reconstructive procedures in the head and neck region.

The size of the flaps being harvested varied between $3.5 \times 4.4$ cm and $6.0 \times 11.0$ cm for the radial flap and $3.5 \times 5.0$ cm and $6.5 \times 15$ cm for the ulnar flap.

Allen’s test was performed on all patients before surgery to test the ability of the hand to be perfused by either the ulnar or the radial artery. A pneumatic tourniquet was always used to facilitate flap dissection.

Design of the ulnar forearm flap was always defined by drawing, using common anatomic landmarks before starting surgery. The center of the skin island is usually located above the course of the vessel and in the second dimension approximately at the border of the distal to the middle third of the forearm. Sometimes the position was shifted to reach a non–hair-bearing area. We always start the flap dissection from the distal end of the marked skin flap. By use of this method, after defining the vascular pedicle and the ulnar nerve, we have the option to shift the position of the skin island in case the course of the ulnar vessels do not fit with our drawing. All four superficial ulnar arteries could be identified at this early stage of flap harvesting. After realizing the presence of a superficial ulnar artery, in two of the four cases we had to change the position of the skin island of the flap to localize it above the course of the vessel. This was necessary because the superficial ulnar artery in these two cases was crossing the forearm in a more distal position compared with the usual course of the common ulnar artery.

**FIGURE 1.** Main arteries of the forearm. Left drawing, common anatomy. Middle and right drawings, two variants of the course of the superficial ulnar artery.
If a superficial ulnar artery was found during surgical preparation, a superficial ulnar artery flap was raised. In these cases, an arteriography was performed postoperatively to figure out the vascular pattern in the contralateral arm.

RESULTS

During dissection of fasciocutaneous forearm flaps based on the ulnar artery in four (3.7%) of 107 forearms, a superficial ulnar artery was found in 3.3% of women and 3.9% of men.

None of these vascular malformations were identified preoperatively by Allen’s test. The presence as well as the source of the superficial ulnar artery was always figured out during flap harvesting.

We were unable to identify any superficial ulnar artery in the course of dissection of a radial forearm flap, nor did we notice any impairment of such an artery.

In the four cases in which a superficial ulnar artery was identified, it was crossing the forearm in an epifascial layer without running beneath any flexor muscles from the elbow joint up to the wrist (Figure 2). Close to the wrist, the course was always superficial but otherwise similar to the common ulnar artery. Exploration of the usual location of the ulnar artery under the flexor carpi ulnaris muscle revealed no artery adjacent to the ulnar nerve.

Without being able to measure their sizes, it can be stated that the superficial ulnar arteries in all four cases were smaller in diameter than the size of the common ulnar artery. They were all...
accompanied by two venae comitantes that were comparatively small in diameter.

Of the 103 ‘common ulnar forearm flaps’ within this series, six failed to survive (5.8%); one of the 27 radial flaps was lost (3.7%).

We never found any clinical signs of impairment of the blood perfusion of the hand after forearm flap transfer.

The four ‘superficial ulnar artery flaps’ nourished by the superficial ulnar artery and drained by one comitant vein all survived. Surgical revision became necessary in one of these cases on the second postoperative day because of venous congestion caused by thrombotic formation.

Postoperatively, we were not able to figure out the more proximal course of the superficial arteries in the upper arm by performing arteriography or duplex sonography.

Nevertheless, postoperative arteriography revealed a bilateral vascular anomaly in one of the four cases. In this patient, the superficial ulnar artery in the nonsurgical explored side arose about 10 cm proximal to the elbow joint. The brachial artery branched out into the radial and a strong interosseous artery. In this case, the deep palmar arch was dominantly nourished by branches of the radial artery, whereas the superficial palmar arch was not established (Figures 3 and 4).

**DISCUSSION**

The superficial ulnar artery was described in numerous articles as an anatomic variation, as well as being a possible risk factor for accidental intra arterial infusion, for sacrificing the vessel by mistake during surgery. Furthermore, it can cause problems in brachial arterial catheterization.5,6

In reconstructive surgery, the forearm is one of the most frequently used donor regions for free soft tissue transfer. For many years, the radial forearm flap has been the most popular micro-vascular flap to be used for reconstructive procedures in the head and neck region. Nevertheless, its ulnar pendant has some advantages, which resulted in this flap also being the first option in our institution. We prefer the ulnar forearm flap because the skin is less hair bearing in the ulnar forearm region, especially in most of the male patients. The more concealed donor area in the medial (ulnar) region is better accepted, especially by women, in contrast to the difficulty in camouflaging the donor region located at the radial (lateral) aspect of the forearm. Furthermore, after ulnar forearm transfer, muscles form the wound ground of the donor defect instead of exposed tendons in the radial donor site, which might be an explanation for a lower complication rate in the ulnar site after skin grafting of the donor defect.8

The slightly higher flap failure rate within our ulnar artery flap group may be caused by the fact that all of the radial forearm flaps, the superficial ulnar artery flaps, and approximately 80% of the ulnar forearm flaps were harvested by one surgeon (PS), whereas the remaining 20% of ulnar forearm flaps included the learning curves of two more surgeons. Other articles, as well as our own formerly published results, showed no differences in survival rate between these two flaps.

Allen’s test is the only mandatory and widely used preoperative examination to guarantee the circulation of the hand after sacrificing the radial or ulnar artery. In accordance with Thoma and Young,9 we were not able to detect vascular anomalies like superficial ulnar artery by using Allen’s test. Nevertheless, the superficial ulnar artery may be diagnosed clinically by careful palpation of the antecubital fossa and forearm.1,4

The incidence of the superficial ulnar artery seems to have distinct regional differences. Investigations of the vascular pattern of the upper limb in large series revealed quite a different frequency of this anomaly.1,5,10–16

Because in the clinical routine the use of Allen’s test will not lead one to figure out the presence of a superficial ulnar artery, we can proceed on the assumption that in almost all cases of harvesting forearm flaps, the surgeons will be unprepared for any kind of vascular anomaly.

Some authors give warnings about the risk of damaging the superficial ulnar artery by mistake during harvesting radial forearm flaps.1,9,11,17 On the other hand, just a very few articles describe clinical evidence of chronic ischemia of the hand after a radial forearm flap or just the radial artery was harvested, whereas some hundreds of these flaps, as well as radial arteries, may be used for myocardial revascularization every year around the world.18–20 The conclusion is that in most cases when a superficial ulnar artery is present and replaces the regular ulnar artery, it is not noticed and, above all, not damaged during radial flap preparation. Nevertheless, there is always the risk of damaging a superficial ulnar artery if it is present.
Like the common ulnar artery, the superficial ulnar artery forms the superficial palmar arch with a contribution from the superficial branch of the radial artery. The deep palmar arch is predominantly nourished by the radial artery with a contribution from the deep branch of the ulnar artery. Both branches arch out to the digits to guarantee a sufficient blood supply. Sacrificing the radial artery by harvesting a radial forearm flap and damaging the superficial ulnar artery as well will lead to disastrous ischemia of the hand.

Not always are both branches completely established. Coleman and Anson figured out in a large series of specimens that the deep palmar arch was completed in 97%, whereas the superficial palmar arch was complete in only 79% of their subjects. In our own case of a bilateral superficial ulnar artery, the arteriography showed a distinct dominance of the radial artery in nourishing the deep palmar arch in the nonsurgical explored side, whereas the superficial palmar arch was not established (Figure 4).

Fortunately, several investigations revealed a functional and hemodynamic adaptation of the contralateral branches after sacrificing the radial or ulnar artery. These results, as well as the clinical observation of a very low rate of complications at the donor site caused by chronic ischemia, lead to the conclusion that vein grafting after forearm flaps is not recommended on a routine basis.

Summarizing the differences between harvesting fasciocutaneous radial or ulnar forearm flaps with regard to the presence of a superficial ulnar artery, the following facts should be considered:

In the daily clinical routine setting, vascular anomalies like superficial ulnar artery will usually not be identified preoperatively.

In raising radial artery based flaps, the sacrifice of any arteries that cross the forearm in a superficial layer should be avoided, especially if it is not sure whether there is an ordinary ulnar artery present.

In raising ulnar artery–based flaps, it may be possible to harvest a superficial ulnar artery flap instead and save the radial artery in case this kind of vascular anomaly is present. The superficial ulnar artery flap was found to be an easy and safe alternative in these circumstances.

The superficial ulnar artery may be neither curse nor blessing in harvesting fasciocutaneous forearm flaps. It may be a calculable anatomic variation as long as its possible presence is considered during flap harvesting.

REFERENCES


