The Angular Branch

Maximizing the Scapular Pedicle in Head and Neck Reconstruction

Amy J. Wagner, MD; Stephen W. Bayles, MD

Objective: To evaluate the scapular free flap based on the angular artery in complex head and neck reconstruction.

Design: Case series.

Setting: A tertiary referral center.

Patients: A series of 25 osteocutaneous scapular flaps was performed from August 2000 through January 2005. Of these 25 flaps, 7 procedures of scapular bone solely vascularized by the angular artery and vein were performed to reconstruct head and neck defects. The angular vessels were used to reach the neck for anastomosis in midfacial reconstruction (n = 2), to carry a separate second bone flap in complex oromandibular defects (n = 2), and to reach the contralateral neck for anastomosis in through-and-through oromandibular defects encompassing overlying facial skin (n = 3).

Main Outcome Measures: Pedicle length and flap viability.

Results: Postoperative bone scans revealed all bone segments to be vascularized. The pedicle length originating from the circumflex scapular vessels varied from 6.7 to 9.0 cm (mean length, 7.5 cm). The pedicle length of the angular vessels varied from 13.0 to 15.0 cm (mean length, 14.1 cm), a mean length of 6.6 cm longer than the circumflex scapular flap. Vein grafts were not necessary to perform remote anastomoses with the additional pedicle length.

Conclusions: The angular vessels can reliably supply the scapula. Use of the angular vessels over the circumflex scapular vessels increases the bone pedicle length by a mean length of 6.6 cm (88%) and is a useful technique to avoid vein grafting for remote anastomosis.


The scapular flap has become an extremely valuable tool in reconstructing the head and neck. The ability to carry multiple skin flaps, latissimus dorsi muscle, serratus anterior muscle, as well as scapular bone, all on a single pedicle, makes this system of flaps uniquely suited for the complex 3-dimensional sculpting necessary in the head and neck. In addition, some authors1,2 have noted the growing role of the scapular flap in head and neck reconstruction, particularly in the elderly population, because it offers no limitation in patients' ability to ambulate postoperatively, unlike fibula and iliac crest flaps.

The primary blood supply to both the overlying skin of the scapular region and the lateral border of the scapula is the circumflex scapular artery.3 One criticism of the scapular flap over the iliac crest or fibula flaps has been that the circumflex scapular pedicle is shorter. In 1988, Deramaecker et al4 first described an additional vascular branch of the thoracodorsal artery called the angular branch, which supplies blood to the wing of the scapula. More recently, Coleman and Sultan5 described the use of this pedicle to form a bipedicled osteocutaneous scapular flap using the angular branch solely to supply bone on 6 of 8 cases. The angular artery was subsequently defined through anatomic dissections as having 4 vascular patterns of origin from the thoracodorsal and serratus arterial branches. An injection study6 confirmed its vascular contribution to the lateral border, wing, and inferior aspect of the medial scapula. A description of the length of the angular branch was included in these anatomic dissections measuring from the branch point off the thoracodorsal root in cadaveric specimens, but the overall length of the pedicle up to the axillary artery was not commented on.6 Therefore, the additional advantage gained over the circumflex scapular pedicle was not truly defined. A series of 7 of 25 cases of osteocutaneous scapular flaps is described herein. The length gained by ligation of the circumflex scapular bone perforators in an operative setting to free the pedicle solely on the angular branch is emphasized, as are the opportunities where this enhancement can be used to the reconstructive surgeon's advantage.
Patients were placed in the decubitus position with an axillary role to prevent brachial plexus compression. The scapular skin flap was positioned over the triangular fossa, marking the site of the circumflex scapular pedicle’s entrance to the skin (Figure 1). The skin was raised in a subfascial plane over the latissimus, infraspinatus, and teres major muscle approaching the triangular fossa. To identify the angular branch of the thoracodorsal artery, the latissimus muscle was reflected inferiorly from the teres major muscle. The angular pedicle was consistently located overlaying the chest wall between the teres major muscle and the latissimus muscle (Figure 2).

Exposure was enhanced by raising the arm anteriorly in an abducted position at 90° because this rotated the scapular wing medially, opening the axillary chest wall space. Without this maneuver, the angular branch may be obscured under the lateral portion of the scapula, particularly if it has a more cephalad branch point from the thoracodorsal vessels. The entire axillary space was then exposed by releasing the teres major muscle from the lateral border of the scapula (Figure 3). Again, it is important to identify the angular branch prior to releasing the teres major muscle. It can be inadvertently injured if not visualized; its course is in close proximity to the insertion of the muscle at the scapular wing. After both the circumflex scapular pedicle and the angular pedicle have been thoroughly isolated and traced to their confluence with the subscapular vessels, the lateral scapula was then harvested with both pedicles intact to the bone. Division of the bone perforators of the circumflex scapular vessels was then performed once the flap was transferred to the head and neck to ensure the proper orientation of the angular branch (Figure 4).

Care needs to be taken when the soft-tissue component exists separately from the bone because these independent composites have more freedom to become torsed.

After harvest, measurements from the tip of the subscapular artery to the lateral scapula along the circumflex scapular artery were made. The circumflex scapular bone perforators were then divided, and additional measurements were made from the tip of the subscapular vessels to the scapular bone along the course of the angular vessels.

The flaps were then used to reconstruct a given defect. Bone viability could not be inferred by the viability of the overlying skin owing to the dual blood supply from both the circumflex scapular and angular pedicles. Therefore, bone scans were performed on postoperative day 5.

The existence of the angular vessels was visually confirmed on all 25 dissections of the scapular osteocutaneous flap performed from August 2000 through January 2005. Of these 25 cases, 7 procedures of scapular bone solely vascularized by the angular artery and vein were performed to reconstruct head and neck defects. All flaps survived entirely, and bone vascularity was confirmed by bone scan on postoperative day 5. One patient developed a fistula 2 weeks after surgery that required reexploration, which confirmed bone viability.

The angular vessels were used to reach the neck for anastomosis in midfacial reconstruction (n=2), to carry a separate second bone flap in complex oromandibular defects (n=2), and to reach the contralateral neck for anastomosis in through-and-through oromandibular defects encompassing overlying facial skin (n=3). The pedicle length to the bony segment when derived from the circumflex scapular vessels varied from 6.7 to 9.0 cm (mean length, 7.5 cm). The pedicle length offered by the angular vessels varied from 13.0 to 15.0 cm (mean length, 14.1 cm) (Table). The mean increase in pedicle length sacrificing the circumflex scapular perforators to the

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**METHODS**

Patients were placed in the decubitus position with an axillary role to prevent brachial plexus compression. The scapular skin flap was positioned over the triangular fossa, marking the site of the circumflex scapular pedicle’s entrance to the skin. The skin was raised in a subfascial plane over the latissimus, infraspinatus, and teres major muscle approaching the triangular fossa. To identify the angular branch of the thoracodorsal artery, the latissimus muscle was reflected inferiorly from the teres major muscle. The angular pedicle was consistently located overlaying the chest wall between the teres major muscle and the latissimus muscle. Exposure was enhanced by raising the arm anteriorly in an abducted position at 90° because this rotated the scapular wing medially, opening the axillary chest wall space. Without this maneuver, the angular branch may be obscured under the lateral portion of the scapula, particularly if it has a more cephalad branch point from the thoracodorsal vessels. The entire axillary space was then exposed by releasing the teres major muscle from the lateral border of the scapula. Again, it is important to identify the angular branch prior to releasing the teres major muscle. It can be inadvertently injured if not visualized; its course is in close proximity to the insertion of the muscle at the scapular wing. After both the circumflex scapular pedicle and the angular pedicle have been thoroughly isolated and traced to their confluence with the subscapular vessels, the lateral scapula was then harvested with both pedicles intact to the bone. Division of the bone perforators of the circumflex scapular vessels was then performed once the flap was transferred to the head and neck to ensure the proper orientation of the angular branch. Care needs to be taken when the soft-tissue component exists separately from the bone because these independent composites have more freedom to become torsed.

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**RESULTS**

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**Figure 1.** Parascapular skin flap marked over the triangular fossa. **Figure 2.** Axillary exposure is achieved by separation of the latissimus dorsi muscle to the left and teres major muscle to the right. A, Angular branches identified in the space between the latissimus dorsi muscle and teres major muscle. B, Release of teres major muscle insertion provides wide access to the subscapular system of vessels. Ax indicates the axillary artery; angular, the angular artery; CSA, the circumflex scapular artery; and TD, the thoracodorsal artery.
scapula and allowing the bone to be supplied by the angular vessels was 6.6 cm. Vein grafts were not required in any case of scapular osteocutaneous reconstruction as a result of reliance on the enhanced length offered by the angular vessels.

**COMMENT**

The parascapular system of flaps represents a unique composite of tissue with the ability to transfer large areas of overlying skin, latissimus muscle, serratus muscle, and scapular bone. These characteristics make the scapular system of flaps very advantageous, particularly for complex, 3-dimensional reconstruction in the head and neck. Although the bone stock offered by the lateral border of the scapula is not as dense as that of the fibula or iliac crest and therefore generally less accepting of dental implantation, the independent nature and variety of soft-tissue characteristics define this flap’s role in complex head and neck reconstruction. One additional potential disadvantage of the scapular flap is that the circumflex scapular pedicle is generally much shorter than that offered by a fibular osteocutaneous flap or iliac crest flap. However, as Urken et al have noted, the fibula and iliac crest flaps may be less advantageous in the elderly population in whom ambulation is essential for postoperative recovery. In addition, some of the largest through-and-through facial defects are best reconstructed by the independent mobility and surface area of tissue offered by the scapular flap.

In 1988, Deraemaeker et al first described an additional vascular branch of the thoracodorsal artery called the angular branch supplying the wing of the scapula. Since this description, Coleman and Sultan described use of this pedicle to form a bipedicled osteocutaneous scapular flap using the angular branch to solely supply bone in 6 of 8 cases. This pedicle was subsequently defined through anatomic dissections to have 4 patterns of takeoff from the thoracodorsal and serratus arterial branches, and injection study confirmed its vascular contribution.

<table>
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<th>Patient No.</th>
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Abbreviations: AB, angular branch; CS, circumflex scapular.
to the lateral border, wing, and inferior aspect of the medial scapula. The most common pattern seen in 51% of cadaver dissections was the angular branch originating from the thoracodorsal artery and vein distal to the branches going to the serratus anterior muscle. Description of the length of the angular branch was included in these anatomic dissections measuring from the takeoff from the thoracodorsal root in cadaveric specimens. However, the overall length of the pedicle to the auxiliary artery was not commented on, and the additional length gained over the circumflex scapular pedicle was not defined. Although valuable anatomic information was gained from these in situ cadaveric dissections, the translation to usable pedicle length for positioning in a clinical situation should also be analyzed.

Others have used this pedicle for unique applications in the head and neck with success. Urken et al published the largest single experience of scapular osteocutaneous flaps, describing the angular branch’s use in 7 of 57 cases. This pedicle was also used with transfer of both latissimus and scapular bone in lower extremity reconstruction in 12 cases by Allen et al.

A series of 7 cases of 25 osteocutaneous scapular flaps is presented. The length gained by ligation of the circumflex scapular bone perforators in a surgical setting to free the pedicle on the angular branch and opportunities where this enhancement can be used to the reconstructive surgeons advantage are emphasized. All bone flaps based solely on the angular vessels survived, and bone vascularity was confirmed by bone scan on postoperative day 5.

The vascular pedicle was used to reach both the ipsilateral and contralateral neck in cases of midfacial reconstruction with orbital exenteration, in complex oro-mandibular defects, and in through-and-through lateral mandibular defects. In those cases in which the contralateral neck had to be reached or the midface was being reconstructed, vein grafts would have been necessary if the flap was based off of the circumflex scapular vessels owing to inadequate length (Figure 4). In these settings, the angular branch was harvested in addition to the circumflex scapular pedicle, and measurements were obtained to define the applicable pedicle length in these clinical situations. In situ measurements would not take into account small losses of length owing to the ligation of vessels that do not become usable, and cadaveric studies cannot completely represent vessel redundancy and pliability mimicking viable tissue.

The pedicle length to the bony segment when based off the circumflex scapular vessels varied from 6.7 to 9.0 cm (mean length, 7.5 cm). The pedicle length offered by the angular vessels varied from 13.0 to 15.0 cm (mean length, 14.1 cm) (Table). The mean increase in pedicle length sacrificing the circumflex scapular perforators to the scapula and allowing the bone to be supplied by the angular vessels was 6.6 cm (an 89% increase). This added length obviated the need for vein grafts, which have been shown to have a higher failure rate in microvascular transfer.

The skin flaps were designed to be longer and the proximal portion was deepithelialized because of the discrepancy between the length of the soft-tissue component and the vascular pedicle. We have found this to be preferable to harvesting a latissimus or serratus flap with the scapular flap. The added bulk of the latissimus flap is often undesirable, and the degree of atrophy of the muscle does not allow for as desirable a long-term result. In addition, it has been our experience that shoulder function seems to be considerably more affected with scapular bone harvest if the stabilizing serratus anterior or latissimus muscle is sacrificed. We have found that redundancy in the pedicle is not problematic because the added length is used fully in reaching the distant recipient vessels.

The added pedicle length of the angular branch offers advantages comparable to those of the fibula and iliac crest pedicles, and, therefore, the scapula is a viable option when greater distances must be reached. The benefits of the added 15 to 20 minutes of harvest time needed to isolate the angular branch greatly outweigh those of added time needed to harvest a vein graft and perform dual anastomoses. The scapular flap should be considered in cases in which longer distances must be reached. Other flaps may provide inadequate tissue and cause considerable disadvantage to the patient’s functional status after surgery.

Submitted for Publication: September 10, 2007; final revision received December 23, 2007; accepted January 15, 2008.

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Author Contributions: Drs Wagner and Bayles had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: Bayles. Acquisition of data: Wagner and Bayles. Analysis and interpretation of data: Bayles. Drafting of the manuscript: Wagner and Bayles. Critical revision of the manuscript for important intellectual content: Wagner and Bayles. Administrative, technical, and material support: Wagner. Study supervision: Bayles.

Financial Disclosure: None reported.

REFERENCES