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Fasciocutaneous flaps of the subscapular artery axis to reconstruct large extremity defects☆

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Summary *Introduction:* The scapular, parascapular and thoracodorsal artery perforator (TDAP) flaps represent fasciocutaneous flaps derived from the subscapular artery axis. These flaps can be harvested individually or combined as conjoint flaps, tailored to reconstruct a wide variety of defects in the extremities.
Analysis and methods: All patients undergoing free-flap reconstruction at North Bristol trust with a fasciocutaneous flap of the subscapular axis from April 2006 until April 2010 were included. This cohort of 45 patients was retrospectively analysed. The Enneking score for return of limb function was used as an outcome measure after reconstruction. Donor-site morbidity analysis was carried out prospectively using Oxford Medical Research Council (MRC) score, Vancouver Scar Scale and disability of arm, shoulder and hand questionnaire (DASH) scores.
Results: A total of 45 patients had extremity reconstruction using flaps of the subscapular artery axis following severe limb trauma, often comprising open tibial fractures. A total of 42 patients had lower limb injuries and three had upper limb injuries. All flaps survived. The mean Injury Severity Score (ISS) was 9.3, the mean Enneking score was 27 at 12 months mean follow-up. In the nine conjoint flaps, the mean area of tissue resurfaced was 257 cm^2.
Conclusions: In this case series of fasciocutaneous flaps of the subscapular artery axis, we establish that these flaps are robust and versatile. They replace 'like-with-like' and have good patient satisfaction. The donor site can be closed primarily, is discrete and has minimal donor morbidity. The conjoint flaps can be used for reconstruction of very large defects without the need to sacrifice functionally important muscle.

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Background

Open long bone fractures occur with a frequency of 11.5 per 100 000 persons per year in the UK.[1] Open tibial diaphysis fractures are the most common. Lower limb open fractures are more severe than open fractures of the upper limbs with greater associated soft-tissue damage and subsequent deep infection carrying the risk of a delayed amputation.[2,3] Timely and appropriate coverage of large traumatic defects in the lower limb is crucial to limb survival and outcome.[2,3]

Microvascular reconstruction techniques are now entering the fourth decade and complex one-stage reconstruction of the extremity is now possible, being performed routinely in specialist orthoplastic centres.[4] The use of free myocutaneous and fasciocutaneous flaps has been advocated in the reconstruction of defects both in the acute and chronic setting for extremity salvage, with comparable outcome measures.[5]

The dorsal thoracic trunk has long been recognised as a source of transferrable tissue.[6] The scapular flap was first described by Gilbert[7] and Barwick[8] in 1982, the parascapular flap by Nassif et al in 1982,[9] the conjoint scapular/parascapular flap by Koshima et al. in 1985[10] and the thoracodorsal artery perforator (TDAP) flap by Taylor et al. in 1987.[11] These fasciocutaneous flaps provide the greatest coverage potential of any fasciocutaneous flaps and have been used successfully either by themselves[7–9] or in combination[10–14] for the reconstruction of extremity defects. However, little data exist for donor-site morbidity, complications and patient satisfaction.

This study represents our experience in a series of 45 patients requiring extremity salvage using fasciocutaneous flaps of the subscapular artery axis, over a 4-year period, performed by a single surgeon. This series aims to evaluate the use of these flaps, the surgical outcome and donor-site morbidity.

Anatomy

The scapular flap, parascapular flap and the TDAP are based on the blood supply from the subscapular artery axis. The anatomy of the subscapular artery axis is reliable and has been well described previously by Roswell et al.[15]

Anatomical studies have also shown that the scapular flap and the parascapular flap are both fasciocutaneous flaps with the circumflex scapular artery lying within the dorsal thoracic fascia, on top of the epimysium.[16]

Materials and methods

Patient selection and management

From April 2006 until April 2010 at Frenchay Hospital, Bristol, patients who had undergone extremity reconstruction by the senior author, using scapular, parascapular, TDAP or a conjoined combination of these free flaps were included in our study.

Table 1 shows the patients' aetiology. Acute injuries comprised both regional and direct traumatic events ($n = 34$) and were treated according to our standardised protocol.[17] Chronic aetiology patients comprised both regional and local referrals ($n = 11$). All patients were imaged as per national standards, prior to the definitive procedure, with a computerised tomography angiogram (CTA) to ensure patency of recipient vessels.

Table 1 Complications.

Timing	Type	Number	Percentage/%
Early	Venous intimal flap	1	2
	Venous congestion	1	2
Middle	Tip necrosis	4	9
	Significant flap area loss	1	2
Late	Bony infection	3	7
	Bony non-union	1	2

Patients were marked preoperatively using the first dorsal web space technique.[18] Intra-operatively, the patient was positioned laterally with the injured leg lowermost. The flap was taken from the upper-most (contralateral) side. The exact flap size was determined at this time and the donor site carefully marked accordingly. A two-team surgical approach was used, one team excising the extremity wound and preparing the recipient vessels whilst the other team raised the flap using a siege technique. Microsurgical anastomosis and insetting was performed concurrently with primary closure of the donor site.

Postoperative care followed a strict protocol for 5 days.[17] Serial C-reactive protein (CRP) blood checks were performed after day 4 as a surrogate marker of deep infection.[19] Patients were then discharged after 7 days following a 2-day period of physiotherapy.

Follow-up occurred at regular intervals for a minimum of 12 months within a specialist orthoplastic limb reconstruction clinic.[4] Enneking questionnaires were used as a proxy of patient-reported outcome measure (PROM). We also assessed the time to fracture union.[20]

To analyse donor morbidity, we performed a pilot study, recruiting the patients who were reconstructed using the larger conjoined flaps. Donor-site morbidity was conducted by our head upper limb physiotherapist. Donor appearance was assessed with the Vancouver scar scale[21]; power with the Oxford MRC score[34]; and functionality with the disability of arm, shoulder and hand questionnaire (DASH).[22]

Data collection and analysis

An anonymised retrospective database was produced from patient records. We collected data on: patient demographics (age, sex and occupation); initial insult (laterality and anatomical location, mechanism of injury and date and injury severity score); patient background (premorbidities and medication history); initial management (operation detail and date); definitive management (angiogram results, operation details including flap choice, defect size and ischaemic time); and follow-up details (complications, further operations and Enneking scores).

A further prospective database was produced for the donor-site morbidity study looking at the results of the