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The transverse lumbar perforator flap: An anatomic and clinical study

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Summary *Background and aims:* Lumbosacral defects are complex reconstructive problems requiring tension-free vascularised soft tissue reconstruction in patients who often have co-morbidities. In an area prone to recurrent tissue breakdown, both free and islanded flaps risk complete failure. Cadaveric studies have demonstrated the consistency of lumbar perforators, yet ipsilateral lumbar perforator flaps have modest reconstructive potential owing to geometric limitations. An axial pattern lumbar perforator flap based on a contralateral lumbar perforator may surmount these problems; however, it has only been described in a small clinical and cadaveric study previously.
Methods: An anatomical study was performed in the consecutive patients undergoing computed tomographic angiography (CTA) of the trunk, assessing the presence and location of lumbar artery perforators. The use of midline or contralateral lumbar artery perforators in the lumbar perforator flap was assessed in the reconstruction of lumbosacral defects.
Results: A total of 102 patients with 102 lumbosacral defects have been managed with the use of contralaterally based transverse lumbar perforator flaps over a period of 20 years. In 96 patients, the defects requiring reconstruction followed debridement of a pressure ulcer, with seven cases following debridement of pilonidal sinuses and one following abdomino-perineal resection. There were 65 men and 37 women, with a mean follow-up of 1.5 years. Necrosis of the tip of the flap occurred in 3%, with no cases of complete flap loss. Recurrence occurred in two cases (both sacral pressure sores). All recurrences and/or necrosis were managed with flap advancement or skin grafts. All the donor sites were closed directly.

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Conclusion: The contralateral-based transverse lumbar perforator flap is a simple, reliable, versatile and, in some cases, reusable choice in the management of lumbosacral defects. Flap dimensions of 24 × 15 cm can be based on one lumbar perforator.

Introduction

Soft tissue defects of the sacral region are complex reconstructive challenges characterised by undermined tissue, oedema, ischaemia, bacterial contamination and recurrence.[1] Successful surgical management relies on excising all the affected tissue, covering with well-vascularised soft tissue, avoiding suture lines in the pressure areas and preserving surgical alternatives in the anticipation of recurrence.[2] The traditional approaches include the transverse latissimus dorsi myocutaneous flap,[3,4] the transverse lumbosacral back flap[2] and the thoracolumbar sacral flap.[5] However, myocutaneous flaps require the sacrifice of muscle creating a functional deficit in ambulant patients. The muscle is also more sensitive to subsequent ischaemic insults.[1] The lumbosacral back flap has a limited arc of rotation, requires a back cut and demands grafting of the donor site. The thoracolumbosacral flap requires extensive dissection and also requires a back cut. More recently, a number of islanded perforator-based flaps have been proposed.[6–12] Kato et al. first described a perforator flap based on the fourth lumbar perforator.[13] While the fourth lumbar perforator was found to be of consistently good calibre, the flap was islanded owing to the perception of poor blood supply across the midline. However, in 1991, the senior author (BSM) published a provisional clinical series attesting that the lower lumbar perforators reliably crossed the midline to supply a contralateral-based axial pattern flap.[14] Basing a transverse lumbar flap on the contralateral lumbar perforator thus permitted a greater flexibility in flap design and arc of rotation and negated the need for islanding which is technically more demanding and results in an insensate flap. The results of this cadaveric study have now been used to provide soft tissue cover for 102 midline lumbosacral defects. The authors' clinical experience is described, with previous findings differing from those of Kato and Taylor, in that closer to the midline small perforators are seen that supply a plexus across the midline, on which the flap is based).

Patients and methods

The clinical anatomical component of this study was undertaken comprising a cohort of 500 hemi-posterior trunk walls in 250 consecutive patients undergoing preoperative computed tomographic angiography (CTA) prior to autologous breast reconstruction. All patients were planned for either free DIEP (deep inferior epigastric perforator) or SIEA (superficial inferior epigastric perforator) flaps. All the participants were women, with a mean patient age of 54 years (range 32–70) and a range of body habitus types. Institutional ethical approval was obtained prospectively. The posterior trunk was included in all scan data.

All patients underwent preoperative imaging with CTA, with all imaging performed at a single institution and a single arterial phase scanning protocol employed in each case, which maximised the arterial filling of the lumbar artery and its branches. The scanner used was a 64-slice multi-detector row CT scanner (Siemens Medical Solutions, Erlangen, Germany), with 100 ml of intravenous contrast (Omnipaque 350; Amersham Health, Princeton, NJ, USA). The CTA images were reformatted into maximum intensity projection (MIP) and three-dimensional volume-rendered technique (VRT) images using the commercially available software (Siemens InSpace; Version: InSpace2004A_PRE_19, PA, USA; Figures 1–3). All reconstructed images were reviewed for the presence of the lumbar arteries and their branches, and thin axial slices were used for measurement of its diameter.

Anatomical information recorded included the location of the third and fourth lumbar arteries and their perforators, with measurements from the midline, measured at the level of the deep lumbar fascia (a relatively fixed anatomical landmark in the deep plane). The vessel diameters were recorded as the internal diameter of the vessel to the closest 0.1 mm. All anatomical data derived from the CTA analysis were recorded as absolute values and presented quantitatively in Tables and graphs.

An operative approach was also included, with findings recorded in consecutive patients who underwent lumbosacral reconstruction using this flap between 1991 and 2011

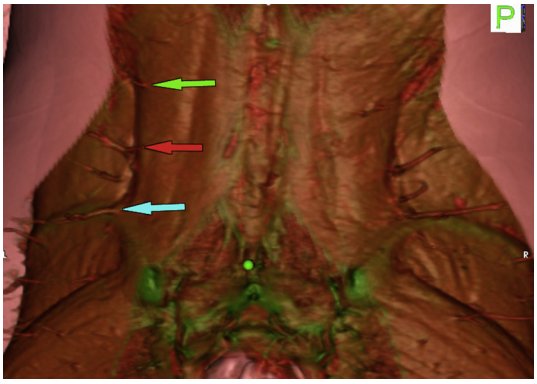

Figure 1 Computed tomographic angiogram of the posterior trunk, with a three-dimensional reconstruction highlighting (arrows) the lumbar artery perforators at the point at which they perforate the deep fascia.

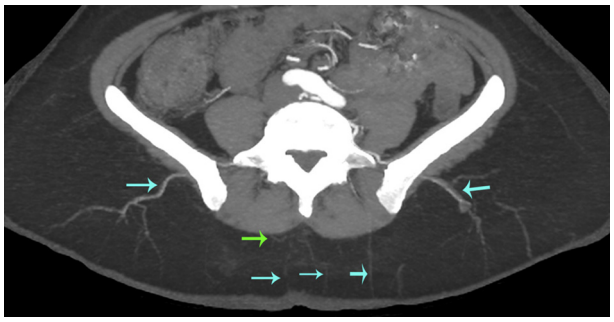

Figure 2 Computed tomographic angiogram of the posterior trunk, with an axial slice demonstrating the medial and lateral row lumbar artery perforators, including a midline perforator (blue arrows). A suprafascial network connecting the perforators is highlighted (green arrow).

Figure 3 Computed tomographic angiogram of the posterior trunk, with an axial slice demonstrating medial and lateral row lumbar artery perforators, including a midline perforator.

included for analysis. Bilateral flaps were used in three patients, depending on the geometry of the defect. All aetiologies were included. Owing to the site and geometry of the defect, some lumbosacral defects favoured another reconstructive option and these were excluded from analyses. Patients not suitable for flap reconstruction owing to premorbid condition were similarly excluded. All data were analysed retrospectively from a prospective database of cases collected by the senior author.

Operative technique

The flap can be consistently and reliably based on the contralateral lower lumbar perforators without the need for Doppler localisation. Superior incision is marked by crossing the midline 1—2 cm depending on the need for rotation. In the authors' experience, a lateral perforator and a medial perforator lie 7—9 cm and 1—2 cm, respectively, from the midline. In addition, multiple small perforators supply a plexus which crosses the midline. The dimensions of the flap must permit relocation to the inferiormost aspect of the defect and has a usual length—breadth ratio of 1:3. The flap is raised as an axial pattern fasciocutaneous flap from lateral to medial with both ipsilateral lateral and medial perforators being divided, whilst preserving the contralateral medial and lateral perforators. This allows a large arc of rotation and the flap can be subsequently rotated into an appropriate position. To the best of our knowledge, this is the first study demonstrating the use of lumbar flaps based on the contralateral perforators. The flap donor defect was closed by advancing the ipsilateral gluteal skin superiorly. In cases of tight closure, the medial donor defect may require undermining in order to permit direct closure of the donor site, or covered with a split skin graft and left to heal secondarily. The flap is sutured in place over suction drains and direct pressure is avoided post-operatively until the wound has healed by nursing prone or in the lateral decubitus position. The patients are nursed prone or on their side until the flap has healed. Avoidance of direct pressure to the flap is considered of paramount importance.

Results

Anatomical study

The use of CTA was able to demonstrate the lumbar artery perforators with high resolution and provide adequate images for assessing the vessel size, branching and location. The 250 abdominal wall scans included perforators arising from the third and fourth lumbar arteries in all 500 sides and also a perforator over 1 mm from each lumbar artery in every case.

The mean diameter of the lumbar artery perforators differed according to the cranio-caudal level, with a trend toward larger perforators with the lower lumbar vessels. With the transverse lumbar flap based solely on the third and fourth lumbar artery perforators, only these perforators were assessed anatomically: the summary findings of all anatomical details are shown in Table 1.

The mean perforator diameter of the third lumbar artery perforators was less than those of the fourth lumbar artery (1.1 vs. 1.6 mm); of those cases with perforators $>$1.5 mm, a larger percentage arose from the fourth lumbar artery than the third (87% vs. 78%).

Most perforators perforated the deep fascia lateral to the erector spinae muscle mass as septocutaneous vessels. A medial perforator, coursing medial to the erector spinae muscles, was present in 97% of cases arising from the fourth lumbar artery and 80% of cases arising from the third lumbar artery. This perforator was larger if it arose from the fourth lumbar artery than if it arose from the third. In 30% of cases, the perforator was in the midline (Figure 3). As described earlier, the contralateral medial perforators are preserved, whilst the ipsilateral medial perforators are divided during the raising of the flap.

Clinical cases

A total of 102 patients with 102 lumbosacral defects were managed using contralateral-based transverse lumbar perforator flaps over a period of 20 years. Reconstruction was proposed in 94% of the cases following a sacral or lumbosacral pressure ulcer, which occurred as a result of immobility in the elderly or as sequelae of the neurological insults. Sixty-four percent occurred in men. Preoperative imaging with the Doppler probe was used in each case, and

Table 1 Anatomical features of the fourth and fifth lumbar artery perforators.

	3rd lumbar artery	4th lumbar artery
Perforator >1 mm present	500/500 = 100% of cases	500/500 = 100% of cases
Mean perforator diameter (for all perforators >0.5 mm)	1.1 mm (range: 1.0 mm −1.6 mm)	1.6 mm (range: 1.2 mm −2.1 mm)
Number of cases with a lumbar perforator of diameter >1.5 mm	390/500 = 78%	433/500 = 86.6%
Presence of a medial perforator within 1 cm of the midline	402/500 = 80.4%	483/500 = 96.6%
Mean "medial" perforator diameter (for all perforators > 0.5 mm)	0.7 mm (range: 0.5 mm −1.2 mm)	0.8 mm (range: 0.5 mm −1.3 mm)

flap design was consistently made, as shown in Figure 4. The contralateral medial lumbar artery perforator was preserved and identified in all cases (Figures 5–7).

Necrosis of the tip of the flap occurred in three flaps (3%) overall, with no cases of complete flap loss. All three flaps were salvaged following debridement and flap advancement. Recurrence of the defect occurred in further two cases (both sacral pressure ulcers) as a result of breakdown of tissue adjacent to the flap. Both cases were managed by local tissue advancement.

All donor sites were closed directly. Partial breakdown at the tip of the gluteal advancement (donor site closure)

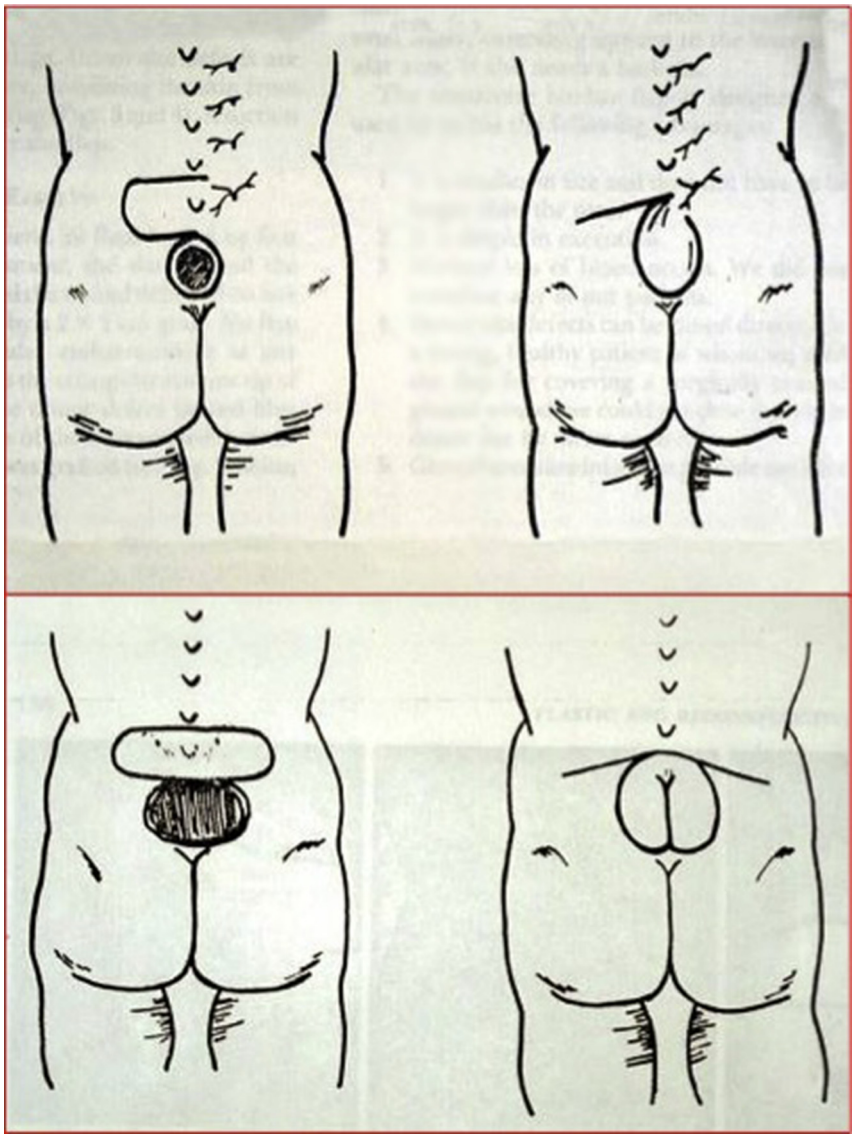

Figure 4 Schematic representation of the transverse lumbar flap (unilateral above, bilateral below).

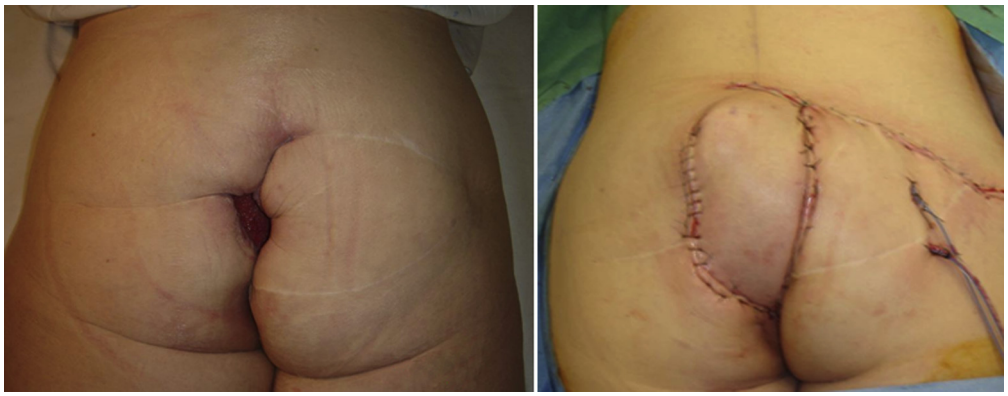

Figure 5 Case example of sacral defect planned for transverse lumbar flap reconstruction (left) and post inset (right).

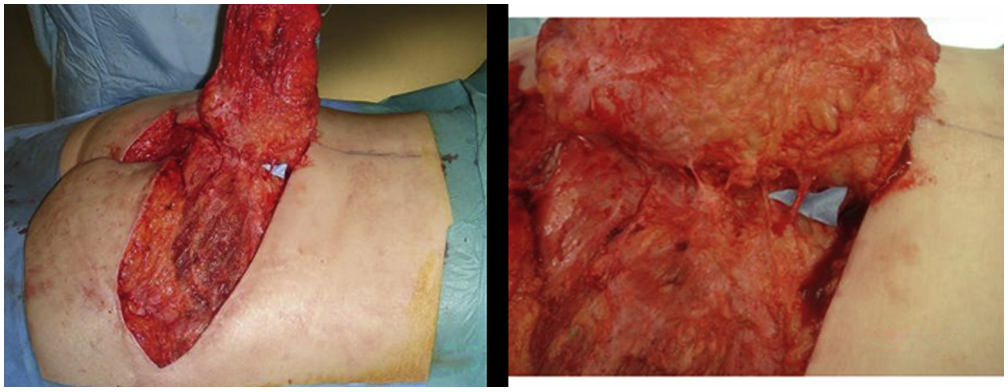

Figure 6 Intraoperative identification of the contralateral medial lumbar artery perforator (same case example as in Figure 5).

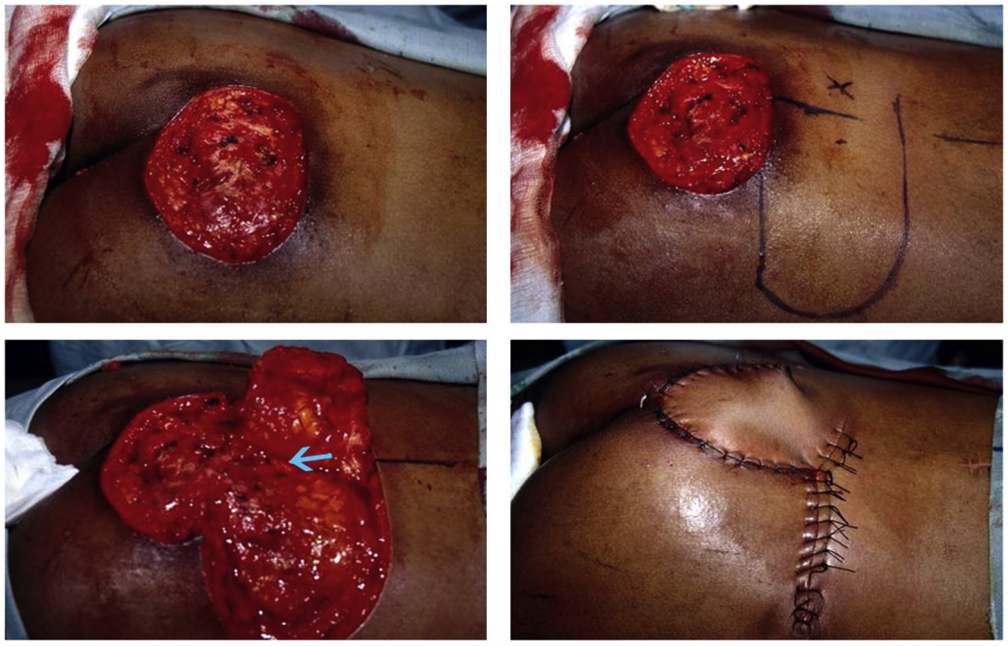

Figure 7 Further case example, demonstrating a sacral pressure ulcer after debridement, Doppler ultrasound identification of the contralateral medial lumbar artery perforator, transverse lumbar flap design and harvest and post inset.

was observed in 12 flaps (12%) treated initially conservatively, and with surgical debridement and secondary closure or grafting in 10 of these cases. Two recurrent sores were managed by local tissue advancement following debridement.

Discussion

The reconstructive management of lumbosacral defects is an evolving field. Random pattern local flaps have given way to musculocutaneous flaps, axial pattern fasciocutaneous flaps based on the subdermal plexus and perforator-based islanded fasciocutaneous flaps. The origin of the approach described in this paper probably stems from work by Kahn who, in 1965, described a rotated lumbar flap for the management of sacral defects following pilonidal sinus surgery.[16] Prior to the advent of the concept of angiosomes, from which stemmed an appreciation of fasciocutaneous perforators, the rotated lumbar flap shared a similar geometry to the flap described but was essentially a random pattern flap raised as a delayed procedure. The study by Hill et al. in 1978 represented significant progress because it not only introduced a perforator-based fasciocutaneous flap to the armamentarium of sacral wound management but also appreciated the potential for lumbar perforators to vascularise skin across the midline.[2] The limitation of this study was the bulky flap, which displayed a limited arc of rotation and required skin grafting of the donor site. The design of this flap was guided by cadaveric studies that hinted at blood flow across the midline but did not demonstrate the true potential of the lumbar perforators to perfuse an axial pattern flap across the midline. These cadaveric studies were not alone in failing to reveal the potential of the lumbar perforators. Recently, in 1999, Kato et al. reported the results of their fluorescein study of 11 cadavers which appeared to support the assertion that the angiosome did not cross the midline.[13] This finding was later supported by a cadaveric study by Offman et al. who used a lead oxide—gelatin injection technique in fresh human cadavers.[17] The most recent cadaveric and clinical studies appear to refute this assertion.[15,18]

Fasciocutaneous flaps offer a durable, like-for-like choice in the reconstruction of lumboscaral defects. The choice of flap depends on the geometry of the wound as well as the premorbid condition of the patient. For example, while islanded perforator flaps may be a reasonable choice for ambulant patients, the principle of recurrence is central to the rationale for managing non-ambulant patients[19]; in this context, islanded flaps risk both early and late non-salvagable loss with the requirement of a secondary procedure to cover a larger defect.[11] The transverse lumbar flap is a reasonable choice for these patients as the flap may be raised and reset in the event of breakdown at the tip. An alternative to the transverse lumbar flap is a gluteal fasciocutaneous rotation flap sparing the perforators as described by Wong et al.[19] This technique is suitable for all lumbosacral defects, avoids the unfavourable midline scar and still permits further options of secondary reconstruction. In addition, it avoids the challenge of microsurgical skills and perforator dissection, which may be technically demanding.

While we have used the transverse lumbar flap mainly for the management of sacral pressure sores, we feel that the flap is an ideal choice for pilonidal sinus management as, in addition to reconstruction of the defect following excision of all the affected tissue, the flap recruits non-hair-bearing skin to the site of the sinus and orientates the scar away from the midline.

Conclusion

Lumbo-sacral soft tissue defects are prone to recurrence following reconstruction, and in patients with coexisting morbidities, simple yet effective strategies to recruit well-vascularised tissue are needed. The contralateral-based transverse lumbar perforator flap is a simple, reliable and versatile option in the management of such defects. Moreover, they can be reset in the event of further tissue breakdown. This technique is not suitable for all lumbosacral defects; rather, it can be added to the armamentarium of flaps used for managing these complex problems. Our experience would suggest maximal flap dimensions of 24 × 15 cm based on one lumbar perforator.

Disclosures/funding

Nil.

Conflicts of interest

None.

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