



Modification of Superior Gluteal Artery Perforator Flap for Reconstruction of Sacral Sores

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Background: Despite advances in reconstruction techniques, pressure sores continue to present a challenge to the plastic surgeon. The superior gluteal artery perforator (SGAP) flap is a reliable flap that preserves the entire contralateral side as a future donor site. On the ipsilateral side, the gluteal muscle itself is preserved and all flaps based on the inferior gluteal artery are still possible. However, the dissection of the perforator is tedious and carries a risk of compromising the perforator vessels. **Methods:** We modified the harvesting technique into two flap designs: a rotational and a tunnel method with only a short pedicle dissection to cover 12 sacral sores. **Results:** All flaps survived except one, which had flap tip necrosis and was treated by secondary closure. **Conclusion:** The advantages of this modification include a faster operation, less bleeding, and less trauma of the pedicle, which make the SGAP flaps an excellent choice for sacral pressure sore coverage.

Key words: superior gluteal artery perforator flap, sacral sore

INTRODUCTION

Pressure sores, especially in the sacral region, are a common recurring complication in patients who are paraplegic or bed bound. Many surgical methods have been used to correct pressure sores, including primary closure, skin grafting, local random flaps, and muscle flaps. Muscle and musculocutaneous flaps have been used successfully in pressure sore coverage^{1,2} and are the first choice for the management of pressure sores because they provide excellent blood supply and durable coverage. On the other hand, limited shifting capacity, excessive blood loss, and sacrifice of the muscle are the major drawbacks of the procedure. The superior gluteal artery perforator (SGAP) flap provides an ample amount of tissue, with good vascularity, to cover large sacral pressure sores in one stage and does not sacrifice the vascularity or innervation of the underlying gluteus maximus muscle³. During the SGAP flap harvesting, meticulous dissection of the pedicle is required, which can be time consuming, tedious, and technique dependent. To

shorten the learning curve and to make the operation easier and faster, we simplified the SGAP flap procedure by making two modifications. First, we modified the flap design by using either rotational or tunnel methods, depending on the size of the defect. Second, we use a short pedicle dissection without skeletonization to prevent vessel trauma and to fasten the operation. This report presents our experience in successful reconstruction of sacral pressure sores using this modified SGAP flap.

Vascular Anatomy

The superior gluteal artery (SGA) arises from the internal iliac artery. The SGA gives off a deep branch to the gluteus medius muscle and then runs through the gluteus maximus muscle, ending in cutaneous arteries located mainly in the superolateral gluteal region. The SGA can be marked on the skin of the buttock at a place one-third of the way on a line drawn from the posterior superior iliac spine to the top of the greater trochanter (Fig. 1). The piriformis muscle can be located topographically on the buttock skin on a line drawn between the greater trochanter and a point halfway to the sacrum. Perforators can be found in the area lateral to the SGA and above the piriformis muscle³. In 1993, Koshima described the detail anatomy of the SGA perforator. The length of the vessels varies from 3 to 8 cm and their diameter from 1 to 1.5 mm. These flaps can be nourished even with only one perforator⁴. In our cases, the largest SGAP flap with one perforator is 12 cm × 13 cm.

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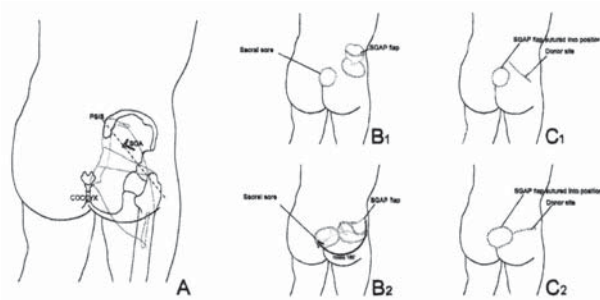


Fig. 1 Stages of the operation using the superior gluteal artery perforator (SGAP) flap. (A) Anatomical landmarks: the SGA emerges at the junction of the middle and medial thirds of a line drawn between the posterior superior iliac spine (PSIS) and the lateral border of the greater trochanter. (B1) The defect is smaller and comprises a skin strip between the defect and SGAP flap. (C1) The flap is sutured into the defect by tunneling the pedicle, and the donor site is closed primarily. (B2) The flap is larger, and the SGAP flap is designed to just close the defect. (C2) The flap is sutured into the defect by rotating the SGAP flap with the pedicle as the pivot point, and the donor site is closed primarily.

PATIENTS AND METHODS

Between April 2003 and July 2006, 12 patients were operated on because of sacral sores. Six were men and 6 were women, and their mean age was 79.8 years (range, 66–90 years). The flap size ranged between 7 cm×9 cm and 12 cm×13 cm. The length of the pedicle dissection is determined by the arc of movement of the flap. For all operations, the length of the perforator dissection did not exceed 1 cm. All defects were grade III or IV pressure sores over the sacral region according to the classification of Shea⁵. Twelve SGAP flaps were performed on these patients. The average follow-up period was 14.8 months. Detailed patient information is given in Table 1.

Operative Technique

With the patient in the prone position, the anatomical landmarks are drawn and the SGA and its perforators are identified with the help of unidirectional Doppler

ultrasound. The locations of the SGA perforators are situated mainly around the junction of the middle and medial third of a line drawn between the posterior superior iliac spine and the greater trochanter³. A template of the defect is drawn on sterile, exposed x-ray film. The template helps ensure that the recipient site and donor tissue are of proper size and shape. The flap template is placed on the perforator mark; when doing so, it is essential to design the skin paddle with an extra 0.5 cm width around the margin of template to ensure the flap has sufficient skin to cover the defect without tension. To cover a smaller sacral sore (usually less than 8 cm in diameter), the SGAP flap is tunneled beneath a skin strip between the defect and the flap donor site. To cover a larger sacral sore (larger than 8 cm in diameter, or when a bilateral conventional V—Y flap is considered), the SGAP flap must be designed close to the defect. The defect will be covered by a rotational SGAP flap (Fig. 1).

The incision is made superiorly and then continued down through skin, subcutaneous fat, and fascia to the muscle. From there, the flap is detached from the muscle until the chosen perforator is encountered, usually in the fibrous perimysium. The vessel is slowly dissected out about 1 cm in length by splitting the muscle fibers rather than by cutting under loupe magnification, and the vessel loop is placed around the perforator. The fibrous septa of the perimysium can be preserved from the dissection. Once the vessel is found suitable, the inferior border of the flap is incised and the flap is raised away from the muscle fully to form an island flap. The island flap can then be transposed into the defect by tunneling the pedicle or by rotating the flap about 180 degrees, as demonstrated in Fig. 1. Regardless of the method used, the length of the pedicle dissection will not exceed 1 cm because of the vascular anatomy of the SGAP, which lies adjacent to the sacral region. All donor sites are closed primarily. We prefer to

Table 1 Patient data

Patient	Age/Sex	Underlying disease	Flap size (cm)	utilization	Complication	Follow-up (month)	Perforator Number
1	89F	Corebral infarection with paraplegia	7×9	Tunnel	Nil	2	2
2	74/M	Parkinson's disease	8×9	Tunnel	Nil	5	1
3	80/M	Pneumonia with respiratory failure	6×7	Tunnel	Nil	1	1
4	90/M	Cerebral infarection with paraplegia	9×10	Rotation	Nil	7	1
5	84/M	Parkinson's and Alzheimer's digease	11×14	Rotation	Nil	8	1
6	81/F	Cerebral infarection with paraplegia	8.5×16	Rotation	Partial Flap necrosis	7	3
7	75/F	Cerebral infarection with paraplegia	7×8	Tunnel	Nil	1	1
8	79/M	Cerebral infarection with paraplegia	8×14	Rotation	Nil	33	1
9	80/F	Cerebral infarection with paraplegia	9×13	Rotation	Nil	39	1
10	80/F	Cerebral infarection with paraplegia	6×8	Tunnel	Nil	33	1
11	66/M	Cerebral infarection with paraplegia	8×8	Tunnel	Nil	41	1
12	80/F	Lumbar fracture	12×13	Rotation	Nil	1	1

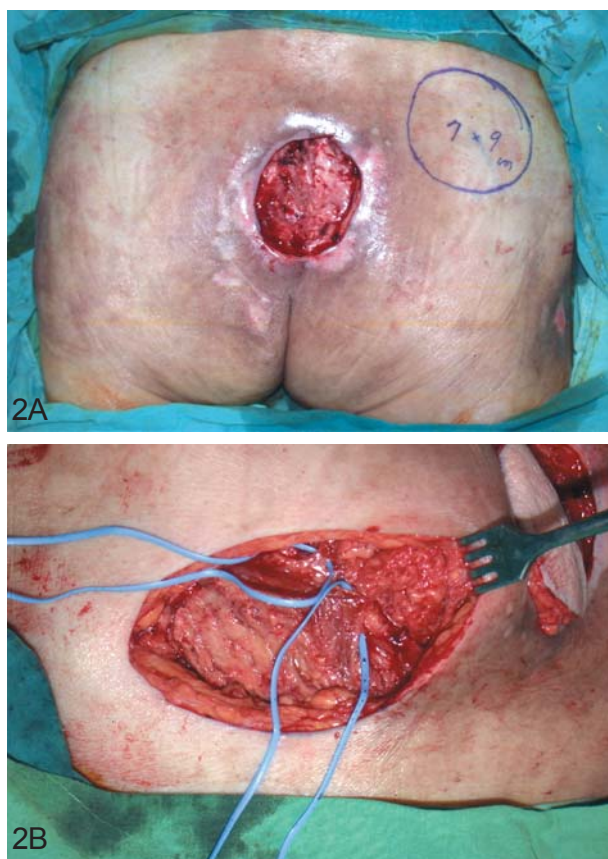


Fig. 2 (A) Planning of a 7 cm $\times$ 9 cm SGAP flap for a 6 cm $\times$ 8 cm sacral pressure sore coverage (Patient 1). (B) The SGAP flap was raised on two perforators. Note that the pedicles were still encased in its fibrous septum and the pedicle length did not exceed 1 cm. The flap was tunneled into the defect from the flap donor site, and the thickness of subcutaneous fat provided ample length to tunnel the flap to the defect without further pedicle dissection. (C) The postoperative result 4 weeks after surgery.

close the donor site first to reduce the tension between the flap and defect. Suction drainage is applied under the flap and in the donor area until amount less than 10 cc is collected per 24 hours. The patient remains prone or on his/her side until the flap heals.

RESULTS

Ten flaps were found with one SGA perforator, one flap had two perforators (Patient 1), and one flap had three perforators (Patient 6). None of our patients required conversion to a musculocutaneous rotation flap. All flaps survived, although venous congestion was common immediately following surgery. Six SGAP flaps (Patients 1, 2, 3, 7, 10, and 11) were sutured into the defect by tunneling the pedicles, and the other flaps (Patients 4, 5, 6, 8, 9, and 12) were sutured into the defect by rotating the flap. Because of short pedicle dissection, all SGAP flap were elevated within half an hour. Only one flap developed tip necrosis, which was healed by debridement and secondary intention. All donor sites were closed primarily and healed without complication. No recurrence was observed during the follow-up period.

CASE REPORTS

Patient 1

An 89-year-old woman with a history of paraplegia was referred with a sacral grade IV pressure sore. After debridement, a SGAP flap measuring 7 cm $\times$ 9 cm based on two perforators was moved into the defect beneath the skin strip and inset without any tension. The donor site was closed primarily. The patient was discharged to a nursing home uneventfully 2 months later (Fig. 2).

Patient 5

An 84-year-old man with Parkinson's and Alzheimer's diseases developed a large midline sacral grade IV pressure sore. After resection of the scarred skin including the ulcer, an 11 cm $\times$ 14 cm SGAP flap was designed to cover the defect. Because the defect was large, the SGA perforator was positioned adjacent to the defect. The SGAP was taken from the zone immediately adjacent to the defect without a tunnel to place the SGAP flap base centrally on the perforators (Fig. 3A). With this design, the SGAP flap does not have a marginal perforator. The defect was covered by rotating the SGAP flap with the perforator as a

pivot point (Figs 3B and 3C). The flap was sutured into the flap and the donor site was closed primarily. The patient remains recurrence-free at 8 months follow-up (Fig. 3D).

DISCUSSION

Pressure sores constitute an important problem for both paraplegic and ambulatory patients. Development of pressure sores makes treatment or rehabilitation more difficult and delays routine treatment options. Untreated sores may cause serious complications, including death, and recurrence is still a significant problem after pressure sore surgery. Surgery is the best treatment option in the vast majority of patients^{6,7}.

According to the localization and grade of pressure sores, primary closure, skin grafts, fasciocutaneous, or musculocutaneous flaps may be preferred for reconstruction^{8,9}. The most popular method for closing sacral sores is the gluteus maximus myocutaneous flap, which has many variations including the turnover flap, rotation flap, island flap, and the sliding flap described by Ramirez, which is useful in nonparaplegic patients¹⁰. The major disadvantage of these flaps is the sacrifice of a muscle and its function.

Excessive blood loss and limitations in flap design are other drawbacks. An additional problem is that, in some instances, the suture line of bilateral gluteus maximus myocutaneous flaps lies exactly at the maximal pressure point, resulting in frequent wound dehiscence during recovery.

In 1993, Koshima et al.⁴ found 20-25 perforators supplying the entire gluteal region and used gluteal perforator flaps to cover sacral pressure sores. The beauty of this flap is that a large, safe flap can be raised unilaterally with minimal bleeding and will leave the muscle intact with little donor site morbidity. Verpaele et al.³ described the use of the SGAP flap to reconstruct a large midline sacral defect. Deeply dissecting the perforator vessel from the muscle should obtain a pedicle length of 8.5-10 cm, giving the flap an impressive mobility and the possibility of

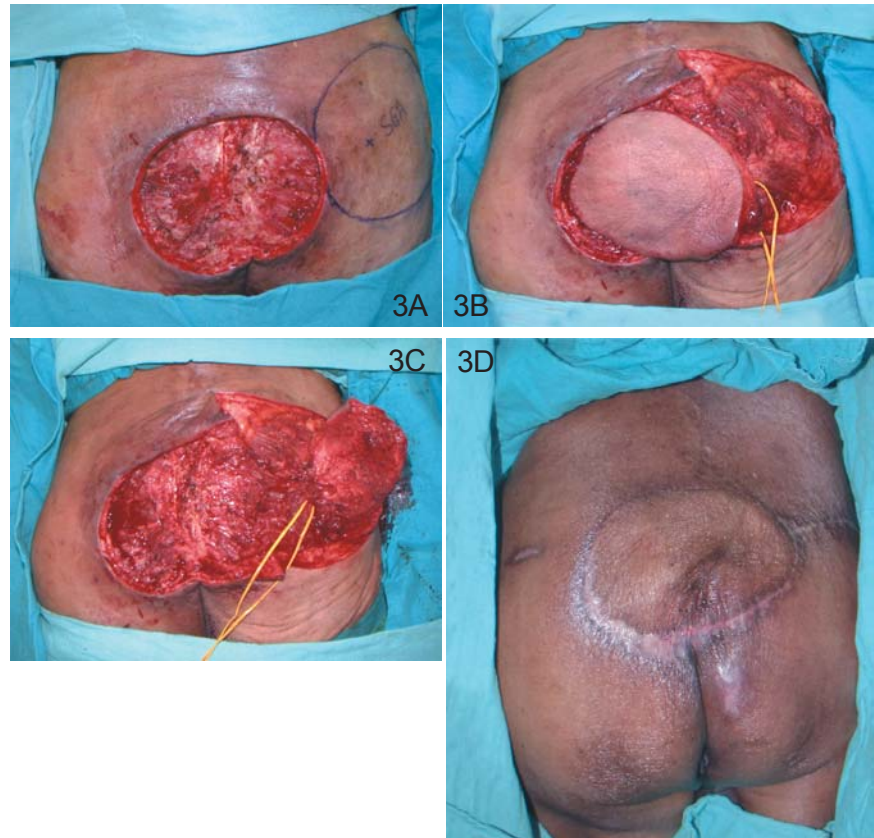


Fig. 3 (A) A large pressure sore located at the midline sacral region and planning of an 11 cm × 14 cm SGAP flap for sacral pressure sore coverage (Patient 5). Note that the flap was designed to just close the defect to avoid injury to the SGAP perforator during harvesting. (B) The flap was raised on one perforator, which was still encased in its fibrous septum. Note that only a very short pedicle was dissected. (C) The flap was rotated about 180 degrees to cover the defect. Note that the previous right side of the SGAP flap reached the left side of the defect without tension. (D) Stable results 7 months after surgery.

covering large defects with a unilateral flap. A long pedicle can be raised if a lateral perforator is chosen, providing the flap a large arc of movement, which allows undamaged tissue to be used from a distant nontraumatized zone in certain cases. However, in some very large defects, the margins of the defect need to be included in the flap³.

In our series, we planned the flap to be 1 cm longer and wider than the defect around the predetermined perforator vessels. In small defects, we included the perforator vessels in the central portion of the flap design, and the flap was tunneled into the defect from the flap donor site. In large defects, we included the margin of defect in the flap and the flap was inset by rotating. In contrast to previous studies^{3,4,11-14}, we found no need to dissect more than 1 cm of length of the pedicle in our 12 patients. The dissection of the pedicle takes time and extreme care should be taken

to avoid injuring the perforator vessel; pedicle dissection is the rate-determining step of the SGAP flap for closure of a sacral sore. Planning the flap to be slightly larger than the defect shortens the length of the dissected pedicle and reduces operating time effectively. Of course, the risk of perforator vessel injury would be also decreased.

We think there are several reasons why our SGAP flaps could cover the sacral sores without needing a long pedicle dissection, (1) because the SGA is often found one-third of the way down the line drawn from the posterior superior iliac spine to the greater trochanter, the perforator vessels will be close to the sacral sore; (2) a larger flap design ensures that the flap has sufficient skin to cover the defect without tension caused by tunneling or rotating fashion; (3) minimal undermining of the defect and primary closure of the donor site places the defect toward the flap and decreases the tension between the flap and defect; (4) the bulk of subcutaneous fat of the SGAP flap provides additional length to increase flap mobility; (5) the furthest end of the sacral sore could be covered by rotating the SGAP flap about 180 degrees, making a long pedicle dissection to advance the flap unnecessary.

For SGAP flaps with more than one perforator vessel, Verpaele et al. suggested that choosing a lateral perforator creates the longest possible pedicle to raise the flap from the distant nontraumatized zone and allows the surgeon to inset the flap with minimal torsion to the vascular pedicle³. We choose the medial perforator vessel as a pivot point to rotate the SGAP flap and found no need to skeletonize the perforator (Fig. 3B). Although rotating the SGAP flap applies torsion to the pedicle, none of the 6 rotating SGAP flaps failed because of a kink at the pedicle. No study has described SGAP flap death from pedicle torsion^{3,4,11-13}. Raising the SGAP flap adjacent to the defect does not influence wound healing postoperatively after adequate wound debridement.

Multiple perforator vessels will restrict flap mobility. A lower number of perforators allows the flap to move more easily and farther¹¹. Using only one perforator may preserve the viability of the flap⁴. We treated only 1 patient (Patient 6) with partial necrosis of the flap, and the SGAP flap had three perforators. The additional perforator vessels do not increase the viability of the flap but provide additional stretch between the flap and defect. Ligation of the marginal perforators may release the tension without compromising the SGAP flap.

In conclusion, sacral sore management is a difficult issue in plastic surgery, and flaps must be chosen carefully. The SGAP flap provides a large, bulky, and safe fasciocutaneous flap to cover sacral pressure sores. The flap also

has advantages of minimal blood loss, mild donor site morbidity, and preservation of muscle function. Like other perforator flaps, pedicle dissection needs a meticulous dissection technique to avoid damaging the perforator vessels, especially for inexperienced surgeons. Our study shows that deep pedicle dissection is unnecessary when the surgery involves an accurate indicating perforator, adequate flap size design, and correct selection of flap utilization between tunnel and rotation. We found that the SGAP flap elevation was easier, faster, and safer. Because raising the SGAP flap is no longer a technique that demands a steep learning curve, we recommend the SGAP flap as a good alternative choice in the management of sacral sores which could not be covered with primary closure or local fasciocutaneous flap.

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