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Clinical Efficacy of Gluteal Artery Perforator Flaps for Various Lumbosacral Defects

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Purpose: Soft tissue defects in the lumbosacral area can be challenging to treat, and various methods to accomplish this have been proposed, including the use of perforator flaps. Herein, we present our experience with superior gluteal artery perforator (SGAP) and inferior gluteal artery perforator (IGAP) flaps for the reconstruction of lumbosacral defects.
Materials and Methods: From March 2013 to July 2016, 28 cases (27 patients) of lumbosacral defects were treated by reconstruction with SGAP or IGAP flaps. The defects were caused by pressure sores (21 cases), burns (3 cases), tumor resection (2 cases), scars (1 case), or foreign body infection (1 case). Reliable perforators around the defect were found using Doppler ultrasound. The perforator flaps were elevated with a pulsatile perforator and rotated to cover the defects.
Results: Twenty-three SGAP and 5 IGAP flap reconstructions were performed. The mean flap size was 9.2×6.1 cm^2 (range, 5×3 cm^2 to 16×10 cm^2). Donor sites were closed by primary closure. Partial flap necrosis occurred in two cases, and minor complications of wound dehiscence occurred in 3 cases, which were healed by primary closure. The mean follow-up period was 4.4 months (range, 1~24 months).
Conclusion: Gluteal-based perforator flaps can be safely harvested due to pliability and reliable vascularity in the gluteal area, reducing donor site morbidity without sacrificing the underlying muscles. Thus, these flaps are useful options for the reconstruction of lumbosacral defects.

Key Words: Soft tissue injuries, Lumbosacral, Perforator flap

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INTRODUCTION

Lumbosacral soft tissue defects are commonly encountered in the field of reconstructive surgery. Soft tissue defects in the lumbosacral area can be caused by pressure sores in hemi- or paraplegia patients, postoperative dehiscence, tumor removal, radiation ulcers, trauma, and burns, etc. Many surgical methods have been developed to correct lumbosacral defects, including primary closure, skin grafting, local random flaps, and muscle flaps. Muscle and myocutaneous flaps, which provide excellent padding, have been traditionally used as a coverage method for skin and soft tissue defects in the sacral area.[1] The gluteus maximus musculocutaneous flap is most commonly used because of its location relative to the defect and excellent blood supply and durability; however, the use of this flap might leave functional deficits in ambulatory patients and eliminate other reconstructive options in relapse cases. Moreover, the recurrence rate after surgical treatment for pressure sores has been reported to be 13% to 61%.[2,3]

Recently, with the advancement of microsurgical techniques, perforator flaps have been used in various cases. Perforator flaps based on the gluteal artery were first introduced by Koshima et al.[4] in 1993. Because gluteal artery perforator flaps provide a considerable amount of tissue with good vascularity, minimize donor-site morbidity, and preserve underlying muscles, superior gluteal artery perforator (SGAP) flaps may be excellent for the coverage of lumbosacral wounds.[5-8] While SGAP flaps have been widely used, only a few reports with objective outcome data regarding the inferior gluteal artery perforator (IGAP) flap have been presented in Korea. Therefore, the aim of the current study was to present our experience with SGAP and IGAP flaps for the reconstruction of lumbosacral defects and discuss the usefulness of these flaps for lumbosacral defects.

MATERIALS AND METHODS

Patients

A retrospective review of 27 patients (18 men and 9 women; mean age, 54.5 years; age range, 22~74 years) who underwent 28 cases of reconstruction with SGAP- or IGAP-based flaps at the Department of Plastic and Reconstructive Surgery of Chosun University Hospital from March 2013 to July 2016 was performed (Table 1). The mean defect size was 6.6×4.9 cm^2 (ranging from 1×1 cm^2 to 15×10 cm^2). The defect etiologies included pressure sores (21 cases with one patient undergoing IGAP flap coverage for pressure sores on both ischial areas), postburn defect (3 cases), tumor resection (2 cases), scar (1

Table 1. Patients reconstructed with gluteal artery perforator flaps

Patient No.	Sex	Age (yr)	Defect size (cm^2)	Cause of wound	Location	Diabetes medication
1	Male	52	8×4	Pressure sore	Sacrum	None
2	Female	71	3×3	Pressure sore	Sacrum	Diabetes
3	Male	64	7×5	Pressure sore	Ischium	None
4	Male	65	14×9	Skin cancer	Sacrum	None
5	Female	65	6×5	Pressure sore	Sacrum	Diabetes
6	Male	44	11×5	Pressure sore	Ischium	None
7	Male	63	7×5	Skin cancer	Trochanteric area	None
8	Male	22	3×3	Pressure sore	Sacrum	None
9	Male	50	10×8	Pressure sore	Sacrum	None
10	Male	66	15×10	Pressure sore	Sacrum	Diabetes
11	Male	58	4×2	Pressure sore	Right ischium	None
			3×3	Pressure sore	Left ischium	None
12	Female	44	6×5	Pressure sore	Sacrum	Diabetes
13	Male	59	6×6	Pressure sore	Sacrum	None
14	Female	74	3×3	Burn	Sacrum	None
15	Female	52	6×5	Pressure sore	Sacrum	None
16	Female	67	7×6	Burn	Sacrum	None
17	Male	58	10×5	Pressure sore	Sacrum	None
18	Male	49	6×5	Pressure sore	Sacrum	None
19	Male	50	1×1	Postburn scar	Sacrum	None
20	Female	27	10×8	Pressure sore	Sacrum	Diabetes
21	Male	59	3×3	Pressure sore	Sacrum	None
22	Male	52	4×3	Pressure sore	Ischium	None
23	Male	26	6×6	Pressure sore	Sacrum	None
24	Male	62	2×2	Postoperative infection	Back	Diabetes
25	Female	56	8×6	Pressure sore	Sacrum	None
26	Male	59	6×5	Burn	Sacrum	None
27	Male	59	10×8	Pressure sore	Sacrum	None

case), and foreign body infection (1 case).

Surgical technique

Surgery occurred once a negative bacterial culture of the wound was obtained. Patients were placed in the prone position. During reconstruction of the sacral defect, potadine-soaked gauze was packed on anus to prevent infection associated with contamination. Preoperatively, adequate debridement of the bone and adjacent soft tissue was performed. If the bone was exposed, necrotic or nonviable bone was excised using a bone rongeur until bleeding from the bone occurred. Then, a hand-held Doppler assessment, guided by anatomical landmarks, was performed to mark the location of the gluteal perforators and the planned rotation flap was marked. SGAP perforators were situated mainly around the junction of the middle and medial third of the line drawn between the posterior superior iliac spine and the greater trochanter. IGAP perforators were located on a marked area around the horizontal middle third of the gluteal region parallel to the gluteal crease.[9] Most of the flaps were elevated with one reliable perforator, and the width of the flap was designed to be 10% larger than the defect size. The incision was made down to the fascial layer of the gluteal muscle. Using electrocautery, subfascial dissection was performed working from lateral to medial. Once the selected perforator was identified, radical skeletonization dividing all the fascial strands around the perforator was performed to prevent kinking.

Circulation was verified with capillary reaction after rotation and drains were placed beneath the flap, which were removed after 48 to 72 hours. The flap was inset into the defect area and the donor site was covered layer by layer. Color, temperature, bleeding, and venous refill of the flap were carefully evaluated at the end of the suture and in the first 72 hours.

RESULTS

Twenty-three cases involved SGAP flaps (one was combined with a split thickness skin graft) and 5 cases involved IGAP flaps (Table 2). The average flap size was 9.2×6.1 cm^2 (range, from 5×3 cm^2 to 16×10 cm^2). Perforator flap survival was complete, with the exception of two cases of partial flap necrosis in patients with diabetes mellitus; the flap loss sites were subsequently covered with a contralateral V-Y advancement flap. Three patients developed minor complications of partial dehiscence in the wound edge, which was closed by delayed primary closure. All donor sites were closed by primary intent, and there were no complications on the suture margins.

Case 1 (Case 25)

A 56-year-old female with paraplegia due to a traumatic fracture on the thoracic spine in 2008 visited to our department for pressure sores in the sacral area. She had a 8×6 cm^2-sized pressure sore, and the muscles were exposed with a significant amount of discharge from a suspected infection. She was treated

Table 2. Summary of results

Patient No.	Flap dimensions (cm^2)	Flap type	Complication	Follow-up (mo)
1	8×5	SGAP	None	3
2	7×4	SGAP	None	3
3	9×7	IGAP	None	12
4	16×10	SGAP	Dehiscence	3
5	10×6	SGAP	Partial loss	6
6	13×6	IGAP	Dehiscence	1
7	9×7	SGAP	None	1
8	6×4	SGAP	None	4
9	15×13	SGAP	Dehiscence	6
10	7×6.5	SGAP	None	4
11	6×4 4×4	IGAP IGAP	None None	3
12	8×7	SGAP	None	24
13	8×7	SGAP	None	3
14	6×5	SGAP	None	4
15	8×6	SGAP	None	2
16	12×6	SGAP	None	2
17	12×6	SGAP	None	3
18	8×6	SGAP	None	4
19	5×3	SGAP	None	4
20	12×10	SGAP	Partial loss	2
21	5×4	SGAP	None	3
22	8×4	IGAP	None	2
23	9×7	SGAP	None	8
24	14×4	SGAP	None	3
25	11×5	SGAP	None	3
26	7×5	SGAP	None	3
27	15×8	SGAP	None	2

SGAP: superior gluteal artery perforator, IGAP: inferior gluteal artery perforator.

via IV antibiotics and debridement of the unhealthy tissue. After the infection on the wound site was controlled, a one-stage reconstruction using a SGAP flap was performed. The skin island, which measured 11×5 cm^2, was rotated to cover the defect. The donor site was closed primarily. No complications occurred at the donor and recipient sites. At the 1-month follow-up, no sign of infection was seen at the operation site (Fig. 1).

Case 2 (Case 24)

A 62-year-old male with a history of surgical intervertebral fusion due to a herniated lumbar disc visited our department for persistent discharge on the operation site. Once a negative bacterial culture of the wound was obtained, primary closure was performed. However, persistent discharge and delayed wound healing due to a suspected foreign body infection occurred. Therefore, a combined operation with a neurosurgeon was conducted for the removal of fixation devices. The defect size was 2×2 cm^2 after removal of the device; however, a large undermining space was found. Therefore, a 14×4 cm^2 de-epithelialized SGAP flap was designed to cover the dead space caused by the foreign body infection. During flap elevation, a reliable perforator was found in the medial margin of the flap. Thus, only perforator skeletonization was performed without intramuscular dissection. After flap elevation, the flap was rotated 180°, and the distal part was de-epithelialized and inset into the defect site to provide adequate coverage. The donor site was closed primarily. The flap survived without any complications. During 3 months of follow-up, his postoperative course was uneventful (Fig. 2).

Case 3 (Case 22)

A 52-year-old male patient with paraplegia due to a traumatic fracture in the thoracic spine in 1995 was referred to us with

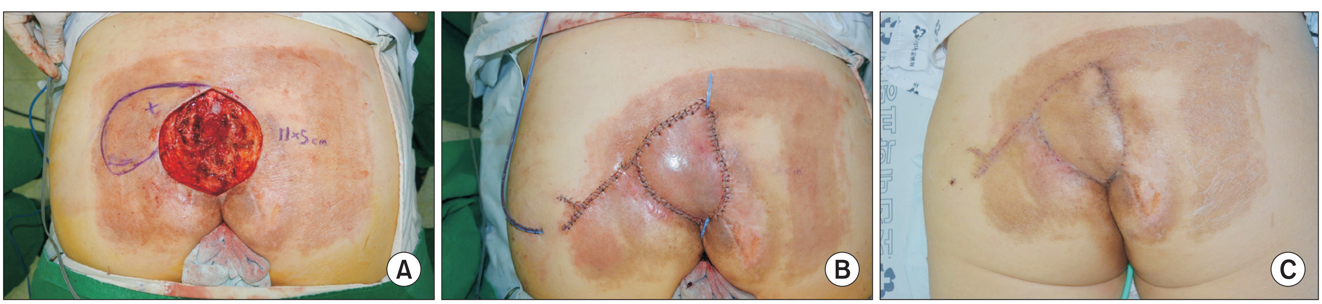

Fig. 1. (A) The preoperative image, superior gluteal artery perforator marking near the defect is shown. Flap size was 11×5 cm^2. (B) The intraoperative image, flap was inset on the defect and donor site was primarily closed. (C) The postoperative image after 2 weeks, there are no complications on flap and donor site.

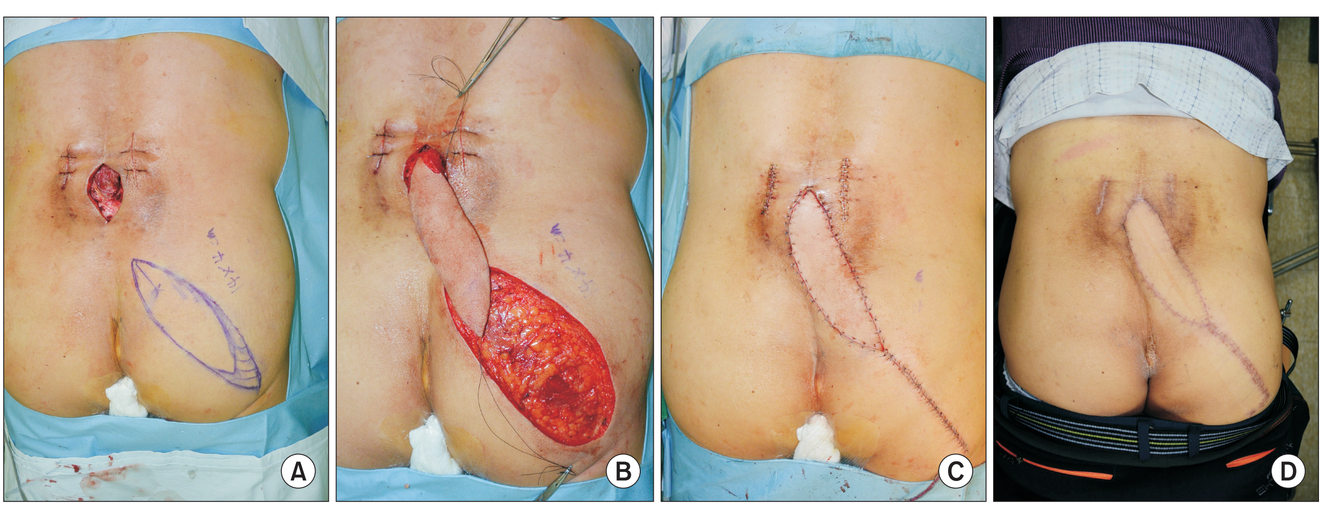

Fig. 2. (A) The preoperative image, about 14×4 cm^2 sized flap was designed in elliptical shape. (B) The intraoperative image, de-epithelialized flap was rotated 180° and inset on the defect. (C) The immediate postoperative image. (D) Follow-up image after 3 months, it didn't showed infection sign.

a grade 3 left ischium pressure sore (size, 4×3 cm^2). He had undergone previous advancement flap surgery twice because of an ischium sore at same site. Debridement, antibiotic therapy, and wound care were initiated. After achieving control of the infection, we performed reconstruction using an IGAP flap rather than an advancement flap. A hand-held Doppler was used to trace the IGAP around the wound site and an elliptical flap (8×4 cm^2), was designed to cover the defect. The flap was rotated 90° and the donor site was closed primarily. The patient showed no recurrence at the 8-month follow-up (Fig. 3).

DISCUSSION

The common causes of lumbosacral defects include pressure sores in paraplegic patients and postoperative dehiscence following spinal surgery. Delayed wound coverage of defects can trigger progressive infections and wound pain. Thus, surgical debridement and subsequent wound reconstructions are the best treatment options for most patients with lumbosacral defects. Pressure sores in paraplegic patients present a particularly difficult challenge because of high rates of wound complication and recurrence.[2,3] Therefore, the gluteus muscle or musculocutaneous advancement flaps have been considered to be the standard first-line treatment for lumbosacral reconstruction as they are reliable and involve a short learning curve for surgeons.[10-12] However, a major weakness of this method is that it causes a disturbance in gait motion in ambulatory patients due to the removal of gluteus muscle from its original body insertion. Other disadvantages include a bulky appearance, limited flap transposition, and unnecessary blood loss when splitting the muscle.

In 1993, Koshima et al.[4] described 20 to 25 perforators supplying the entire gluteal region and used gluteal perforator flaps to cover sacral pressure sores. Gluteal perforator flaps are large and safe and, moreover, can be raised unilaterally with minimal bleeding, leaving the muscle intact with little donor-site morbidity. With the development of this technique, ambulatory patients can be spared from any difficulty in walking since the gluteus muscle is not sacrificed. In paraplegic patients, preserving the gluteus maximus muscle provides an opportunity to repair recurrent pressure sores. Additional reports of sacral-coccyx reconstruction using a gluteus maximus muscle perforator pedicled flap exist.[6,13,14] Based on cadaver dissection studies, of the 7 to 19 perforators dispersed in the gluteal region,[9] the length and diameter of the pedicle is reported to be 3.0 to 9.1 cm and 0.6 to 1.6 mm, respectively.[4,9] In studies based on Korean populations, the average number of perforators from the gluteus maximus muscle has been reported to be 12.2, with 37% of the perforators originating from the superior gluteal artery, while others originate from the inferior gluteal artery. In our series, the mean size of the gluteal artery flaps was 60.5 cm^2 (ranging from 15 to 195 cm^2) and the maximum flap size supplied by one gluteal artery perforator could reach 15×13 cm^2.

The conventional rotation flap (i.e., a fully undermined rotation fasciocutaneous flap) has been used to preserve the gluteus maximus muscle; however, this design pattern does not have a sufficient blood supply due to a random pattern of pedicles.[15] We performed an island-type flap design, with a designed elliptical-shaped skin paddle, and the donor site underwent primary repair. Because a perforator-based flap has a better blood supply compared to that based on a random pedicle pattern, there is an advantage in flap survival rate.

Depending on the location of defect, we used SGAP flaps for the reconstruction of lumbosacral defects, and IGAP flaps for coverage of ischial area defects. SGAP flaps, which are used for

Fig. 3. (A, B) Intraoperative images, inferior gluteal artery perforator flap was designed and inset on the defect with 90° rotational type. (C) The immediate postoperative image, donor site underwent primary repair.

the sacral area, are inadequate for coverage of the ischial area because of an insufficient pedicle length. Traditionally, many experts have used latissimus dorsi and paraspinous muscle flaps to reconstruct defects of the lumbar area induced by postoperative infections or mass removal.[16,17] Recently, experts have started using lumbar artery or posterior intercostal artery perforator flaps due to the development of the microsurgical field.[17] Moreover, SGAP has also been shown to be an effective treatment option for lumbar area defects; Moon et al.[8] covered the undermining space of the lumbar area (e.g., pseudomeningocele repair, etc.) using de-epithelialized SGAP flaps. In the present study, we provided our experience with a similar case (Case 2).

The inferior gluteal artery is the other dominant blood supply to the gluteal region. Le-Quang[16] first reported the use of an inferior gluteal musculocutaneous free flap in 1979. IGAP flaps have similar features to SGAP flaps; however, IGAP flaps have a larger cutaneous territory.[9] This has clinical significance for the elevation of bulky flaps on gluteal regions in cases of breast reconstruction. Since pedicled IGAP flaps were used for ischial area pressure sores in 2002 by Higgins et al.,[17] several similar studies have been reported.[18,19] Particular attention must be paid to wound dehiscence in the treatment of bedsores using IGAP flaps, as the ischial area is very mobile and vulnerable to pressure in a sitting position. The present study included 5 cases using IGAP flaps for the reconstruction of defect and postoperative dehiscence occurred in one case. However, the dehiscence was completely recovered via subsequent primary closure.

The present study has several limitations. First, the follow-up period was relatively short. As most patients were paraplegic, frequent hospital visits were difficult unless the pressure sore recurred. Second, 2 cases of flap necrosis occurred in patients with chronic diabetic mellitus. Because patients with diabetic mellitus generally have many vascular complications, such as atherosclerosis and vasoconstriction, we suggest that surgeons should be aware of the patency of the perforator via preoperative computed tomographyangiography. Third, because IGAP cases were fewer in number compared to SGAP cases, the objective comparison between SGAP and IGAP flaps is difficult. However, with accumulated experience, the survival rate and complications of the two flaps may be evaluated.

CONCLUSION

The SGAP and IGAP flaps provide valuable options for challenging defects on the lumbosacral area. Harvesting these flaps without sacrifice of the underlying muscle means not only reduced donor site morbidity, but also more freedom in composing and tailoring the flap. Because of the pliability and reliable vascularity in the gluteal area, wide and long perforator propeller flaps can be safely harvested and the redundant portion of the flap can be useful in clinical situations such as pressure sores. Therefore, we suggest that these flaps should be considered as useful treatment options for various lumbosacral defects.

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