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Breast reconstruction with Superior Gluteal Artery Perforator free flap: 8 years of experience

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Summary *Introduction:* The SGAP flap represents an alternative for autologous breast reconstruction when DIEP is not available. In this article, we report eight years of experience in breast reconstruction using SGAP free flap and discuss our results, how our procedures have evolved, the outcomes and complications rates and how to perform this procedure efficiently while managing the challenges inherent to this type of flap.
Materials and methods: A retrospective study was conducted from June 2009 and June 2017. Patients requiring SGAP flap breast reconstruction were enrolled. Donor site availability was categorised into 4 classes according to the availability of tissue. An *ad hoc* outcome scale was created to standardise the results and ensure data comparability.
Results: A total of 119 patients were enrolled in the study. We recorded 18 cases of excellent results, 57 good, 30 moderate and 14 poor.
Our results show that donor site class impacts complications and patient outcome.
The odds ratio analysis demonstrated that the third class donor site has a protective impact on complications and has a direct correlation with good patient outcomes.
Conclusions: SGAP flap can provide very good outcomes, and it should be considered as another option when DIEP is not available. Patient selection and efficiency are the keys to achieve optimal results and minimise complications. Although this flap is available for patients with a low BMI, the donor site has to provide enough tissue to achieve symmetry with the contralateral breast and allow a tension-free closure without contour deformity.

Introduction

The superior gluteal artery perforator flap (SGAP) represents an alternative for autologous breast reconstruction.[1,2]

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This option is often not considered owing to its challenging pedicle dissection, the necessity of patient repositioning during surgery, a higher complication rate and lower donor site outcome relative to other types of reconstructions.[2,3]

When a deep inferior epigastric perforator (DIEP) flap is not available, this flap should be considered instead of providing an unsatisfactory result or sacrificing other donor sites with a risk of higher morbidity and permanent functional impairment.[3-7]

In this article, we report our eight years of experience in breast reconstruction using SGAP free flap; discuss our results, how our procedures have evolved, the outcomes and complications rates and how to perform this procedure efficiently while managing the challenges inherent to this type of flap.

Materials and methods

Patient selection

After local review board approval, a retrospective study was conducted between June 2009 and June 2017 to describe the experience of the two senior authors (PR and JF) in SGAP flap breast reconstruction.

Patients diagnosed with breast cancer who underwent mastectomy and either immediate or delayed SGAP flap breast reconstruction were enrolled; the study also included women with a previous implant-based reconstruction, who later underwent SGAP flap autologous breast reconstruction.

Women whose BMI was higher than 35 kg/m^2 were excluded as were those with severe comorbidities (poorly controlled diabetes, hypercoagulability, etc.). Patients who received neoadjuvant chemotherapy underwent surgery 4 to 6 weeks after the end of systemic chemotherapy.

Patients who smoked were requested to stop smoking at the first consultation.

Preoperative evaluation

Donor site availability was categorised into 4 classes (Figure 1):

1. Minimal tissue availability.
2. Thigh closure and insufficient tissue to achieve breast symmetry.
3. Sufficient tissue for tension-free closure and contralateral symmetry.
4. Patient experienced massive weight loss.[8]

The morning of surgery, with the patient in the upright position, the flap site was marked depending on the breast shape, either ipsilateral or contralateral side, according to the location of excess tissue and tissues' tension vectors, and then an external handheld Doppler was used to identify the perforators vascularising the selected area.

Surgical procedure (see the video)

For patients undergoing immediate reconstruction, surgery began with the patient supine for the mastectomy and recipient vessel exposure, and then the patient was turned to the prone position for flap harvesting.

In some patients who underwent unilateral immediate reconstruction, surgery was performed with the patient in

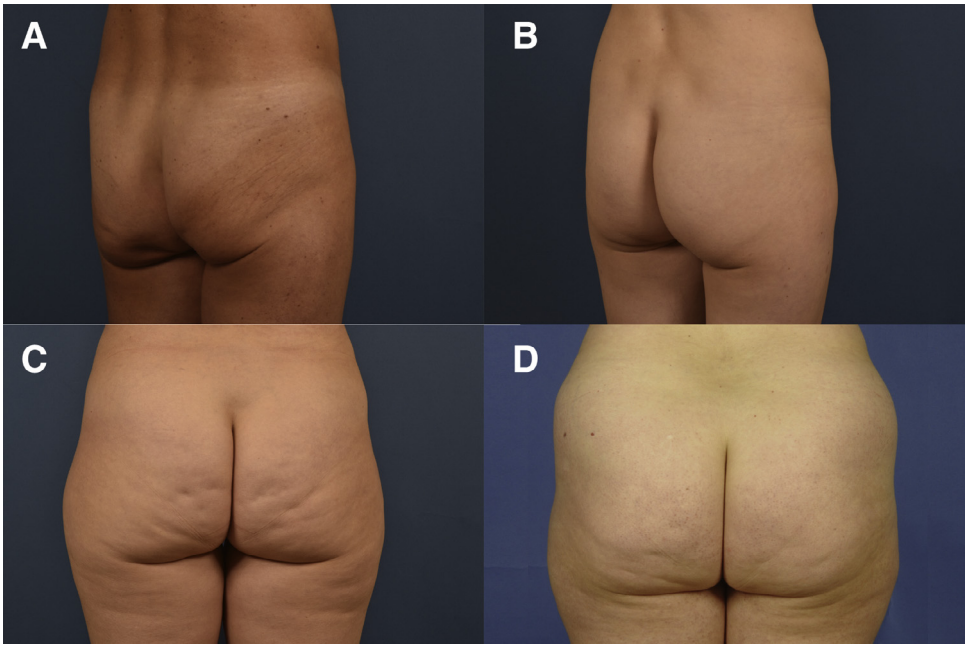

Figure 1 *Example of donor site classes according to our classification*: (A) minimal tissue availability; (B) thigh closure and insufficient tissue to achieve breast symmetry; (C) sufficient tissue for tension-free closure and contralateral symmetry; (D) the patient experienced massive weight loss.

Table 1 Score system and outcome scale.

Parameter	Score system
Breast shape	0: not satisfactory; +1: good shape; +2: excellent shape
Symmetry	0: complete asymmetric; +1: physiologic asymmetry; +2 optimal symmetry
Scaring	0: unacceptable; +1: acceptable; +2: well hidden
Donor site contour	−1: badly distorted; 0: no profile indentation; +1: improved contour
Donor site symmetry	0: complete asymmetric; +1: physiologic asymmetry; +2 optimal symmetry
Complication	−1: complication onset; 0: absence of adverse event.
Reoperation breast	−1: revision surgery required; 0: no revision required.
Reoperation donor site	−1: revision surgery required; 0: no revision required.
Patient outcome	**Score**
Poor	$-1 < x < 2$
Moderate	$3 < x < 4$
Good	$5 < x < 7$
Excellent	$8 < x < 10$

Table 2 Series description.

Age	43	
Range	24-63	
BMI	25.3	
Range	22-35	
	Number of patients	Number of flaps
Immediate		
Unilateral	85	85
Bilateral	12	24
Delayed		
Unilateral	19	19
Bilateral	3	6
Donor site availability		
1	6 pt.	
2	40 pt.	
3	56 pt.	
4	17 pt.	

a lateral position, allowing the flap to be raised simultaneously with the mastectomy; in those patients, the ipsilateral flap was used for the reconstruction.

Internal mammary vessels (IMVs) were selected as the first choice for recipient vessels; they were exposed by removing a fragment of the third or fourth costal cartilage including the intercostal muscles.

Flaps were raised using conventional dissection techniques under loupes magnification until the sacral fascia was reached, and then the dissection up to the pedicle origin was performed with microscope assistance. No vein grafts were used routinely.

The flap was reshaped and pedicle components were dissected and prepared for the anastomoses on a separate table while the patient was repositioned

Data collection and outcome evaluation

Patients' demographic characteristics were recorded.

Surgical data, including oncologic and reconstructive details, were collected from the operating room log book and patients' hospital medical records. Photographic material and outcome data were retrieved from our institutional archive. To assess the evolution of our technique, the patient cohort was categorised by year of surgery, and the temporal trends of number of cases, operative time and complications were investigated accordingly. An *ad hoc* outcome scale was created to standardise the results by ensuring data comparability (Table 1).

Several outcome parameters were investigated; three researchers, external to the study, assessed and scored each parameter of the scale. The scores were summed to obtain the outcome scale that ranged from −1 to 9. The scale average was considered as the final patient numerical outcome, and a categorical outcome, poor, moderate, good or excellent, was constructed by categorising the outcome scale.

Statistical analysis

Descriptive statistics were used to summarise the population characteristics.

Multivariate analysis was performed to assess the association between the donor site class and patient outcome categories. In addition, the odds ratio was used to measure the strength of association between each donor site class and the two binomial outcomes: breast and donor site complications. The χ^2 test was performed to weigh the statistical significance of our findings. Analysis relied on standard software (SPSS v22; IBM Corp., Chicago, IL, USA), setting statistical significance at $p < 0.05$.

Results

During the study period, 119 patients were enrolled, with 104 patients (85.7%) receiving unilateral SGAP surgery. Among them, 19 underwent delayed surgery or had a prior implant-based reconstruction and 85 underwent immediate surgery. The remaining 15 patients (14.3%) underwent bilateral SGAP surgery, including 3 with delayed surgery (Table 2).

Five patients had diabetes, and the mean BMI was 25.3 kg/m^2. The mean sternal notch to nipple distance was 26.7 cm.

Donor site availability was class 1 in 4.4% of patients (6 patients), class 2 in 35% (47 patients), class 3 in 47% (63 patients) and post weight loss (class 4) in 13.6% (18 patients). Ninety-two patients (88.4%) underwent skin-sparing mastec-

Table 3 Type of mastectomy.

	Unilateral	Bilateral
Nipple sparing		
Immediate	12	1
Post implant	0	0
Skin sparing		
Immediate	79	8
Post implant	14	2
Delayed cases (After implant-based reconstruction or simple mastectomy)	16	3

Table 4 Surgery duration and ischaemia time.

Mean ischaemia time (including bilateral flap)	141 min (64-227 min)
Mean ischaemia time (unilateral case only)	76 min (64-123 min)
Mean operative time for immediate reconstructions	7.5 h unilateral (6.1-8.5 h)
	9.3 h bilateral (6.3-11.4 h)
Mean operative time for delayed cases	5.7 h unilateral (4.5-7 h)
	6.3 h bilateral (5.1-7.6 h)
Average raising time	4.1 h (2.3-6.1 h)

Table 5 Outcome according to researchers' evaluation.

Poor	14
Moderate	30
Good	57
Excellent	18

tomy, while only 12 (11.5%) underwent nipple-sparing mastectomy (Table 3).

The mean mastectomy specimen weight was 394 g, and this weight ranged from 274 to 683 g.

The mean flap weight was 465 g, and this weight ranged from 259 to 568 g. The SGAP flap dimensions ranged from 8 to 12 cm wide and from 25 to 30 cm in length.

Ninety-one percent of flaps were based on a single perforator (122 flaps), and only 9% were based on two vessels (12 flaps). The feeding vessels were located primarily in the lateral region of the flap (52.1%). Perforators were also found in the medial region; 26.2% of flaps had a medial perforator. The pedicle length ranged from 8 to 12 cm; in all patients, the sacral fascia was opened to extend the dissection up to the pedicle origin.

Vein graft was used in 4 patients. Only one patient required both a venous and an arterial graft; in this patient, the DIEP vessels were used and the thoracodorsal pedicle was selected as the recipient.

Surgery duration and ischaemia time details are reported in Table 4.

Figure 2 shows the distribution of our experience by year and also the temporal trend of operative time and flap elevation time accordingly to year of surgery.

Our outcome results are summarised in Table 5.

Table 6 Complications following SGAP-based reconstruction.

Total flaps	134
Total complications	56 (37.3%)
Flap complications 16	
Total Failure	5 (3.7%)
Partial Failure	2 (1.4%)
Haematoma	3 (2.2%)
Fat necrosis	5 (3.7%)
Infection	1 (0.7%)
Donor site complications 40	
Seroma	12 (8.9%)
Dehiscence	1 (0.7%)
Infection	4 (2.9%)
Contour deformity	13 (9.7%)
Dog ear	9 (6.7%)
Scar hypertrophy	1 (0.7%)

Table 7 Reoperation rate and symmetrising procedures.

Breast	19 (15.8%)
>Flap reshaping (liposuction)	21 (15.6%)
Lipofilling	8
Donor site	12 (10%)
Scar refashioning	2
Lipofilling	10
Symmetrising procedures	43
Augmentation	5
Mastopexy	21
Breast reduction	17

The associations between outcome categories and donor site class are displayed in Figure 3.

The outcome distribution according to year of surgery is displayed in Figure 4.

Complications are reported in Table 6 and are categorised by donor and recipient site complications.

The associations between complications and donor site class are reported in Figure 5; all the associations were statistically significant, $p < 0.05$, whereas for the outcome-recipient site complication association, the p value was higher than 0.05.

The re-operation rate and symmetrising procedures are reported in Table 7.

Discussion

Autologous breast reconstruction represents an alternative for patients who are not suitable as candidates for implant-based reconstruction or who simply refuse prostheses.[9-11] Worldwide, DIEP is the flap most often used for breast reconstruction; it is a standardised procedure; has high donor site availability, low morbidity and short recovery and provides the possibility of raising the flap simultaneously with mastectomy.[12,13] Other options should be considered when this flap is not available and autologous tissue is the only option to achieve a good outcome.[14] For many reasons, the SGAP flap is not often considered during the reconstruc-

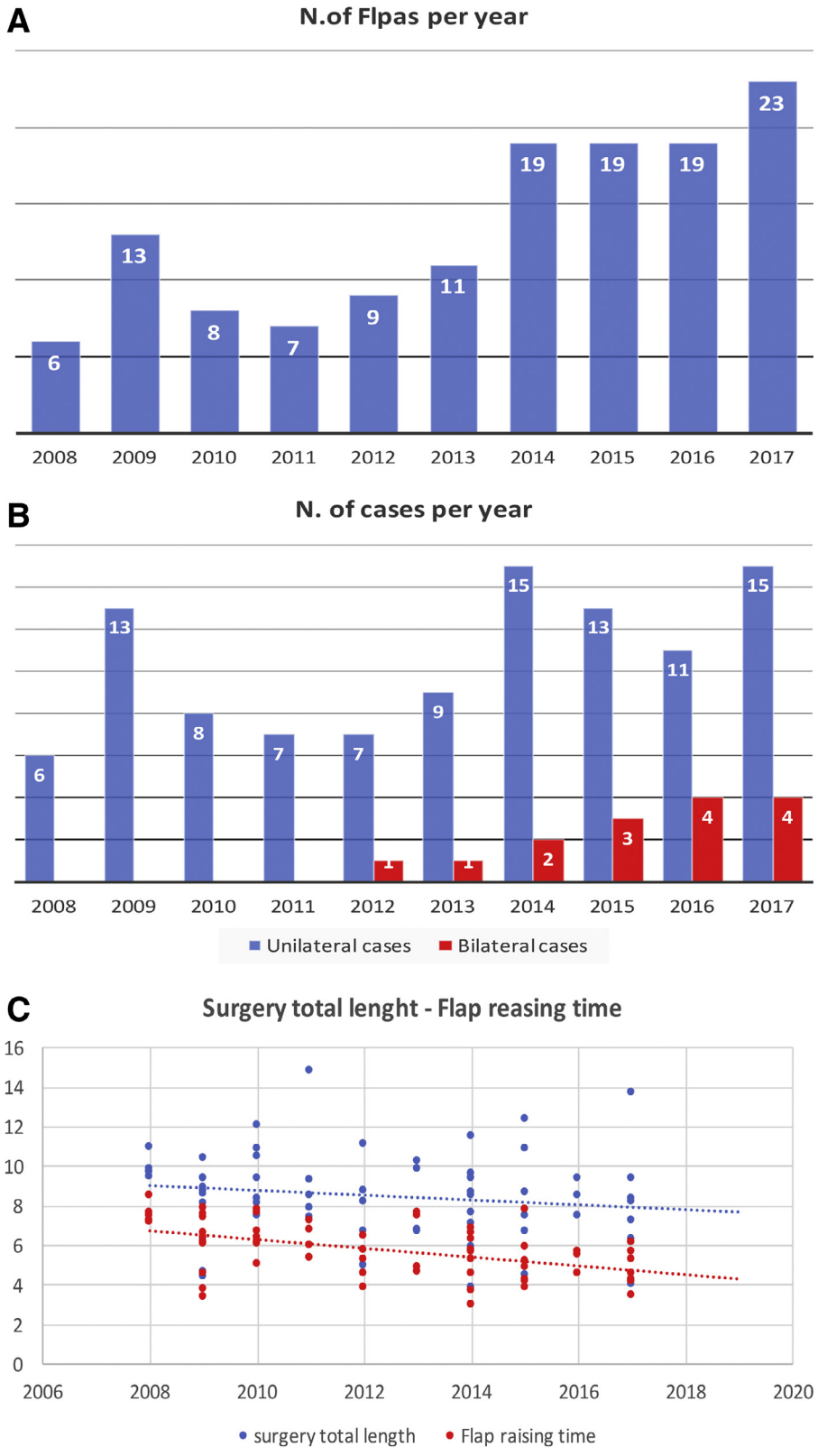

Figure 2 (A) Number of flaps per year (B) number of cases per year. It is possible to see the progressive increase in the number of flaps/cases done while the protocol has been improved. (C) Graphical representation of surgery length and flap raising time. The trend shows a progressive reduction of flap raising time together with the overall surgical length.

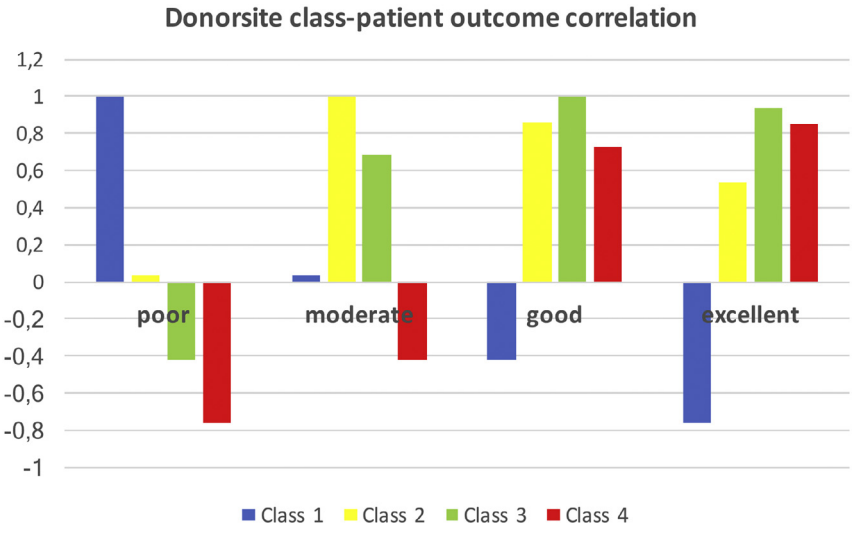

Figure 3 Correlation between the donor site class and the patient final outcome.

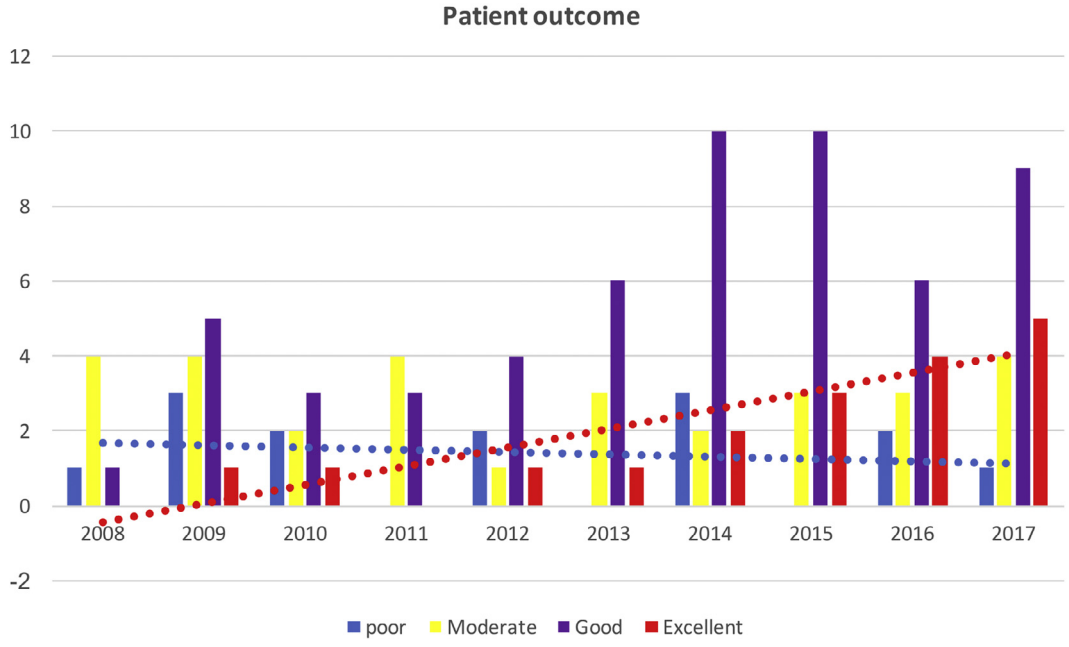

Figure 4 Patient outcome distributed per year' the trend lines show a reduction in poor result and a progressive increase in excellent outcome.

tion algorithm, with many considering this flap almost abandoned and useless. It is our opinion that this flap must be considered as an alternative when DIEP is not available and an implant is contraindicated.

As stated in the report by Flores Jl. et al., an SGAP flap could be mobilised in patients with a low BMI, thereby allowing autologous reconstruction in all women.[15]

When examining our patient series, the BMI was quite low, the average was within normal limits and our results indicate that the amount of tissue that could be recruited ranged from 259 g to 568 g, which is enough to reconstruct even a high-volume breast.

Flap planning is critical to a good breast reconstruction outcome. For DIEP flaps, preoperative perforator imaging has proven effective by shortening the operative time. Our previous research demonstrated that preoperative MRI scan does not affect the operative time for SGAP; we concluded that the use of preoperative scanning is primarily determined by surgeon preference.[16-18]

In breast reconstructive surgery, the pedicle length is more fundamental than that in other anatomical districts. A long pedicle allows greater mobility of the flap and hence provides more freedom for the inset; this allows the new breast to achieve a more natural shape with a higher grade of ptosis, reducing the need for contralateral symmetrisation.

For this reason, as demonstrated in this study, the selection of a lateral perforator is paramount. Although this

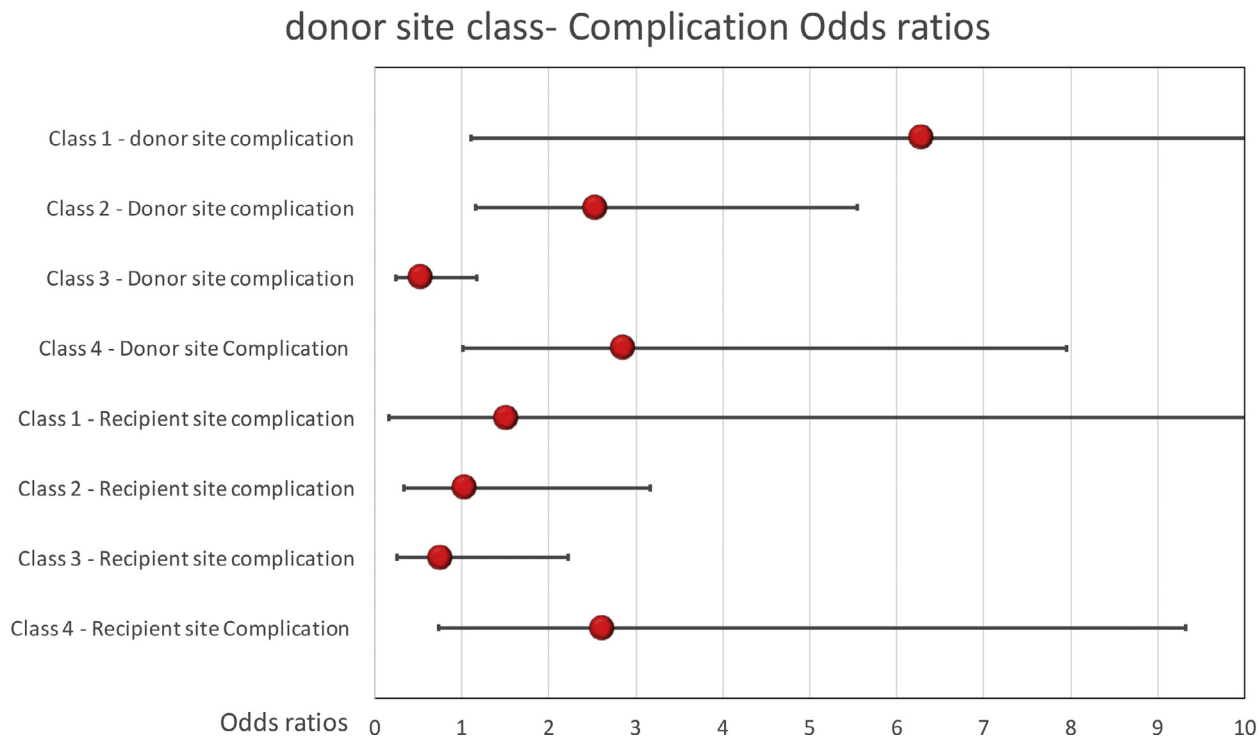

Figure 5 Correlation between complications and donor site. The complications are divided between donor and recipient sites. The odds ratio achieved statistical significance for the donor, whereas the *p* value was always higher than 0.05 for the recipient area.

means a long intramuscular dissection, the pedicle length can reach 12 cm.

Following the same principle, we normally prefer to raise the flap on a single perforator. We base the flap on multiple vessels only in selected patients in whom perforators are close together and travel across the muscle in the same septum.

Considering patient position, as shown in the movie, the SGAP surgery can be performed in several different ways. We routinely start each operation with the mastectomy followed by the exposure of the IMVs, and then the patient is turned prone and the flap is raised; the same sequence is used for bilateral patients. It is our opinion that harvesting the flap simultaneously with the mastectomy, with the patient lying on a flank, should be reserved because in our experience, the dissection becomes more challenging and the risk of perforator avulsion is higher in this position.[19]

The other reason for this caution is related to the flap shape and donor site outcome: fat should be recruited primarily from the lower area of the gluteal fat pad and not taken from the upper region. Using this approach, the buttock shape is most preserved, but this obligates rotating the flap by 180° during the inset. Therefore, the lateral perforator will be positioned far from the recipient vessels, thereby reducing the inset possibilities.

The concept of efficiency is paramount to flap surgery, and for SGAP flap surgery, it is the basis of a good patient outcome. Analysing our experience, we identified some steps that make this surgery easier and also reduce the flap ischaemia time.

To not only gain pedicle length but also to achieve a better vessel calibre, extending the pedicle dissection deep to the sacral fascia is important. Progressing the dissection deep to the fascia can be difficult because illumination of the surgical field may become insufficient due to the surgeon's hands blocking the light in a narrow space. The use of self-retainer retractors and their progressive opening broadens the space during the dissection, and microscope assistance becomes fundamental, not for the magnification itself but for the light source that can easily reach the surgical field.

Another tip to reduce operative time is to reshape the flap and prepare its pedicle for the anastomoses on a separate table while the donor site is closed and the patient repositioned.

Planning each step in advance, so that each member of the surgical team knows his duties, is fundamental, especially in bilateral patients. All efforts should be made to shorten the flap ischaemia time. Our experience demonstrates that the ischaemia time for unilateral patients is slightly longer than that of other types of reconstruction.[20]

We normally inset the flap before performing the anastomoses; this sequence extends the ischaemia time but reduces the risk of vessel avulsion after the anastomosis. Unfortunately, this sequence obligates the surgeon to perform the anastomosis with the flap positioned laterally to the recipient vessels (the flap is between the surgeon and the IMVs) instead of medially as in DIEP flaps. This strategy makes performing the anastomoses more challenging because of the small space available.

As reported, some surgeons prefer to interrupt the dissection at the level of the sacral fascia and then extend the pedicle length with a vein graft.[21,22] We believe that this increases the risk of vascular complications and patient mor-

bidity. In our series, we used an interposition graft in only 4 patients. In these patients, the thoracodorsal pedicle was used as the recipient or flap pedicle was injured or the IMVs were found not suitable for the anastomosis.

The protocol we have developed allowed us to reduce the overall operative time. In parallel to that improvement, we experienced a progressive increase in the number of patients per year. Of course, some patients required more time because the dissection was more complicated, or some problems occurred after the anastomoses.

Our results show that the SGAP flap can provide satisfactory outcomes. The results of our analysis indicate that patient selection is the most critical decision in this type of surgery.

Similar to other autologous reconstructions, mobilising a flap from a donor site where there is not enough tissue to close without tension limits the possibility of achieving symmetry with the other breast and leads to an unsatisfactory patient outcome. A direct association between the donor site class and the final outcome categories was revealed in the multivariate analysis. The results indicated that to obtain good outcomes, the donor site has to provide enough tissue to permit a good donor site closure and symmetry with the other breast. The first donor site class unfortunately experienced moderate/poor results, and the analysis found an inverse association with good outcome. Therefore, we stopped enrolling patients belonging to the first and second donor site classes.

Considering the other donor site classes, it is easy to understand that the outcomes improve, but we underline that unsatisfactory outcomes with class 4 donor sites are still possible. This finding is related to the lower score this donor site outcome had in terms of symmetry, quite often requiring revision surgery. We believe that patients belonging to the third class are the best candidates for this type of surgery.

After we narrowed our inclusion criteria in terms of donor site, we observed an improvement in the overall outcome and fewer unsatisfactory results and complications.

Regarding adverse events, as already reported in literature, SGAP surgery has a high complication rate.[22,23] In our patient cohort, we observed adverse events in 37.3% of patients. Among breast complications, we observed 5 flap losses and other less significant complications, such as minimal fat necrosis, infections and hematomas that, apart from flap losses, are superimposable with other types of reconstructions. This high failure rate could be related to the much more difficult dissection that could lead to pedicle damage and also to vessel discrepancy, producing a challenging anastomosis with greater risk of thrombosis.

Complications were observed more often at the donor site than in the breast; the most common adverse events were contour deformity after donor site closure and dog-ear deformity at the medial end of the scar. Particularly for the latter, we drew the flap so that the correction of the medial dog-ear deformity was already incorporated in its contour.

We are convinced that patient selection is the key to reducing complications. We evaluated the association between donor class and outcomes by estimating the odds ratio for each donor site class to understand how donor class impacts the onset of complications either at the donor site or at the recipient area.

Regarding complication to the donor areas, the class 3 donor site was the only class that had a protective effect on complications (OR = 0.53), including contour deformity. We think that this is because class 3 patients had the best balance between excess adipose tissue and the total buttock volume. Recruiting fat from those women did not affect the outcome of the donor site. In contrast, patients in class 4 were exposed to a risk of asymmetry compared to those in the contralateral side, especially if a large flap was raised.

For patients belonging to class 4, future need for contralateral buttock reshaping to improve symmetry should be stressed. We understand why patients in classes 1 and 2 had greater risk of wound infection, dehiscence and contour deformity. Ten percent of patients underwent donor site revision primarily due to contralateral asymmetry. Scar refashioning was performed in only two patients.

The donor site class had little effect on complications in the recipient area. Classes 1, 2 and 3 had an odds ratio very close to 1, indicating a weak or absence of an association with this outcome. In contrast, for class 4, the OR was 2.64. Analysing this association, we believe that large flaps were more exposed to fat necrosis and asymmetry and hence required more adjustments than the other classes. Only 8 patients had lipofilling, confirming that this flap allows surgeons to provide a good breast shape. We think this is related to the consistency of the gluteal fat that produces more firm results than the abdominal fat. On the other hand, this firm fat consistency is a disadvantage of SGAP[24] because this flap normally sits higher and it is not ideal for reconstructing heavy and droopy breasts, which sometimes require symmetrising procedures.

Conclusions

Although SGAP flap surgery is challenging, it can provide very good outcomes; therefore, it should be considered as another option when DIEP is not available.

If well planned and the team is well instructed about the surgical plan, this surgery may be performed in an operative time that overlaps that of other reconstructions. Patient selection is the key to achieve optimal results and minimise complications. Patient selection should consider aesthetic preference consistent with the patient's culture. Afro-Caribbean patients are known to consider the lower back region very important to feminine beauty, and hence, they tend to often refuse this option.

Declaration of Competing Interest

None.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.bjps.2019.06.027.

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