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# Patient-Reported Assessment of Functional Gait Outcomes following Superior Gluteal Artery Perforator Reconstruction

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**Background:** Harvesting the superior gluteal artery perforator (SGAP) flap involves dissection of vessels through the gluteal muscle, potentially compromising gait and ambulation. We compared patient-reported gait and ambulation problems between SGAP flap and deep inferior epigastric perforator (DIEP) flap reconstructions.

**Methods:** Forty-three patients who underwent bilateral free flap breast reconstruction (17 SGAP, 26 DIEP) participated in the study. The Lower Extremity Functional Score (LEFS) was administered with a supplementary section evaluating gait, balance, fatigue, and pain. Patients evaluated how they felt 2 months postoperatively and at time of survey administration. Multivariate regressions were fit to assess association between type of reconstruction and self-reported lower extremity function controlling for potential confounding factors.

**Results:** Although there was no significant difference in overall LEFS between the cohorts on the date of survey, the SGAP patients reported greater difficulty performing the following activities after surgery ($P < 0.05$): work, usual hobbies, squatting, walking a mile, walking up stairs, sitting for an hour, running, turning, and hopping. The SGAP patients also reported easier fatigue ($P < 0.01$) both during the early postoperative period and on the date of survey.

**Conclusions:** SGAP flap surgery causes no statistically significant differences in overall LEFS. However, SGAP patients did report donor-site morbidity with decreased ability to perform certain activities and increased fatigue and pain in the longer follow-up period. We feel that patients should be educated regarding gait issues and undergo physical therapy during the early postoperative period. *(Plast Reconstr Surg Glob Open 2013;1:e31; doi:10.1097/GOX.0b013e3182a3329f; Published online 14 August 2013.)*

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Many options are available for postmastectomy breast reconstruction. One option for autologous tissue reconstruction is the superior gluteal artery perforator (SGAP) free flap (Fig. 1) first described in 1995.[1] The advent of perforator-based flaps has led to significantly decreased donor-site morbidity in the gluteal region.[2,3] The SGAP flap has been described in the literature as a successful adipocutaneous flap for over a decade,[4]

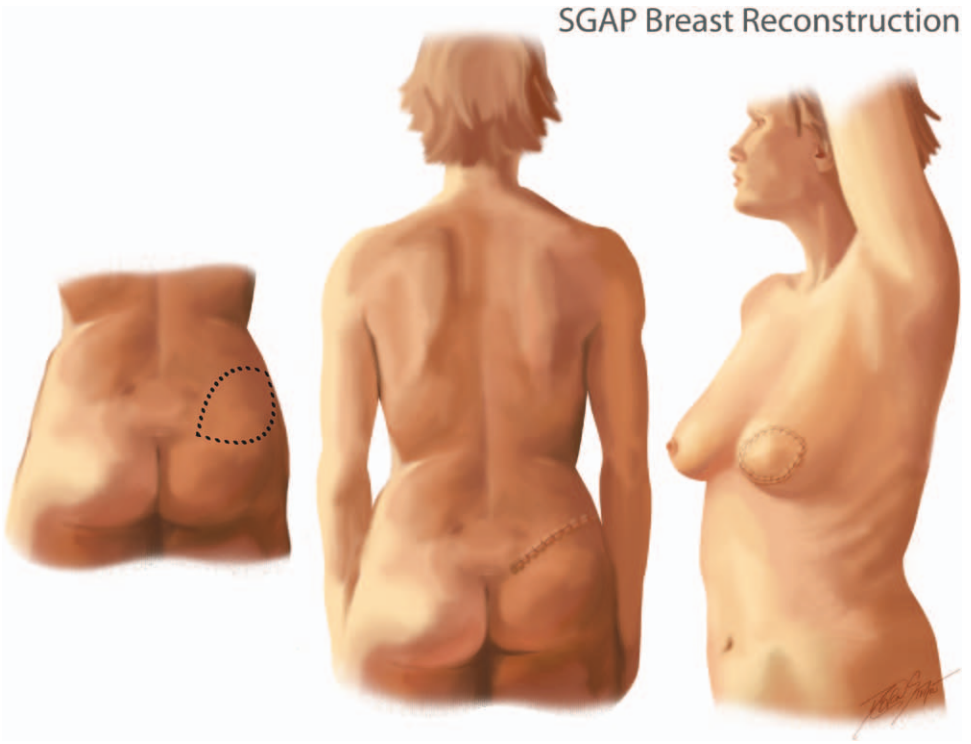


**Fig. 1.** Illustration of SGAP surgery. (Copyright Johns Hopkins Department of Plastic Surgery, used with permission.)

and modifications of flap design to capture septocutaneous perforators to avoid donor-site deformity have been reported.[5] This form of autologous breast reconstruction provides an alternative to implant- or latissimus dorsi flap-based reconstruction otherwise required in patients who lack appropriate abdominal tissue to support the standard deep inferior epigastric perforator (DIEP) (Fig. 2) or transverse rectus abdominis muscle flaps.[6]

However, SGAP surgery remains a relatively uncommon procedure worldwide due to the technical difficulty of the operation. Few centers perform a large enough number of these surgeries to investigate the outcomes of these patients. Donor-site complications such as seromas have been reported,[4,7] but to the best of our knowledge, no study has investigated the long-term functional outcomes. Anecdotally, we have had SGAP patients report postoperative pain and functional deficits in the lower extremity. These reports are plausible given that the gluteus muscle is dissected during the exploration for the perforating vessels. At present, evidence-based information about the potential for, and prevalence of, gait compromise is not available to surgeons or patients making investigation of this issue particularly important.

We hypothesized that the prevalence of lower extremity functional deficits would be significantly greater after SGAP reconstruction compared to DIEP reconstruction. The goal of our study was to compare the short- and long-term lower extremity function, gait, balance, fatigue, and pain between bilateral SGAP and DIEP reconstructions using patient-reported outcomes. We studied demographics, comorbidities, length of follow-up, and complications to elucidate any potentially confounding factors. In addition, we developed a questionnaire to specifically address the potential symptoms and functional deficits of gluteal

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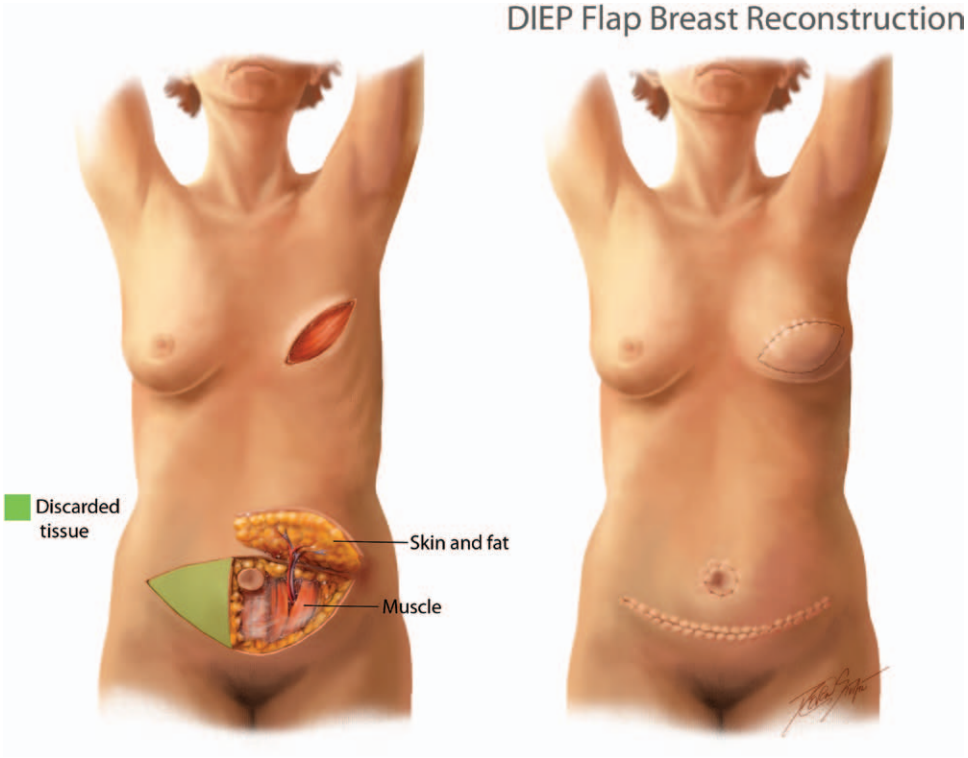


**Fig. 2.** Illustration of DIEP surgery. (Copyright Johns Hopkins Department of Plastic Surgery, used with permission.)

dissection to compliment the Lower Extremity Functional Score (LEFS).

## METHODS

### Population

After obtaining institutional review board approval, a retrospective chart review was initiated using billing codes and electronic medical records to identify patients who underwent breast reconstruction with SGAP or DIEP flaps at Johns Hopkins Hospital between March 2009 and August 2010. Female patients at least 18 years old with bilateral SGAP or bilateral DIEP reconstruction and a minimum of at least 6 months follow-up after their reconstruction operation were eligible for the study. Patients were not recruited at a standard follow-up time to increase the yield of patients who could enroll in the study. To prevent recall bias, each SGAP patient was matched with 1–2 DIEP patients who had their reconstructive surgeries within 2 months of each other. Patients who had failed reconstructions, other major surgeries/procedures during the year of their operation, or were unable to be reached by phone were excluded from the study. As a result, 17 patients who underwent bilateral SGAP flap breast reconstruction and 26 patients with bilateral DIEP flap breast reconstruction were enrolled in the study.

### Survey

A questionnaire was then administered over the phone at least 6 months after the patient's reconstructive surgery. All participants gave verbal informed consent before participating in the study. The questionnaire consisted of 3 components. The first section was a validated 20-item LEFS[8] (Appendix 1), which asked patients to evaluate their condition at 2 months postoperation (time 1). The second section was a readministration of the LEFS survey, except the participant was then asked to evaluate their condition at the present time (time 2: time of survey). Time 2 was between May and July 2011. Although the LEFS questionnaire has been validated for the analysis of activity outcomes in patients with lower extremity musculoskeletal dysfunction, there is currently no published and validated questionnaire addressing specific issues of SGAP/DIEP reconstruction. As a result, the third section of the questionnaire was a 14-item supplementary survey (Appendix 2) carefully developed by the authors with the help of a senior scientist from the Johns Hopkins Bloomberg School of Public Health to minimize bias and to measure issues of gait, balance, fatigue, and pain. The questionnaire was written with enough clarity and at an eighth grade level so that all patients regardless of socioeconomic status or education level could understand the document. All sections used 5-point Likert scales (score, 0–4).

### Operative Technique

#### SGAP

The skin of the patient's buttock is incised in an elliptical fashion, centering on the point of best Doppler signal in the superior gluteal region. The subcutaneous fat is dissected with electrocautery, beveling outward until reaching the gluteal fascia. A subfascial dissection is then developed to identify the best perforators. Smaller perforators are clipped and deselected until the flap is elevated on 1 perforator. Occasionally, this perforator will be a lateral septocutaneous perforator.[5] An identical dissection is performed on the opposite side. Then, with spreading of the gluteal muscle fibers, the perforator is dissected between the gluteal fibers and the subgluteal fascia. The subgluteal fascia is incised and the vessel is further dissected, clipping all the large side branches until the superior gluteal artery is reached; this is then ligated and divided. After the flaps are harvested, the buttock donor sites are then closed in layers over 2 large drains.

#### DIEP

An incision is made through the skin along a preplanned abdominoplasty pattern. A midline incision separates the abdominal flap into 2 hemiabdominal DIEP flaps. The most robust perforators are identified with preoperative guidance from computed tomography angiography.[9,10] The remaining perforators are deselected. The flaps are typically elevated on a single medial infraumbilical rectus abdominis perforator, though other medial or lateral row perforators may be included as appropriate. The anterior rectus fascia is incised, and the perforator is dissected in continuity through the rectus abdominis muscle toward its origin in the groin. Little or no muscle is harvested and crossing motor nerves are left intact whenever possible. After flap harvest, the fascia is closed with a running #0 Maxon (polyglyconate, monofilament synthetic absorbable suture, Covidien, Mansfield, Mass.) looped suture and often reinforced with biologic mesh. The abdominal wall fascia is closed over drains and Scarpa's fascia and skin are closed in layers.

### Statistical Analysis

Descriptive statistics of the study sample were provided for continuous variables such as age (y) and body mass index (BMI) (kg/m$^2$) and categorical variables such as smoking status in the last 12 months (smoker, nonsmoker), diabetes (yes, no), hypertension (yes, no), seroma (yes, no), hematoma (yes, no), and infection or reoperation (yes, no). Means and proportions of these variables were compared by procedure groups using *t* tests and Fisher's exact tests, respectively.

A total LEFS for time 1 and time 2 was calculated, respectively, by calculating the sum of the patient's ratings on the 20 LEFS items. The total scores for time 1 and time 2 were compared by procedure groups, respectively, using *t* tests. Responses for survey items that were asked twice (LEFS questions) for time 1 and time 2 were considered repeated measurements per subject. Each item score was compared by reconstruction procedure groups using ordinary least square regression models with clustering options to account for correlations of 2 responses per subject. Responses for survey items that were asked once for time 2 (supplemental questions) were also compared by reconstruction procedure groups using ordinary least square regression models. Multivariate regression models included reconstructive procedures (1: SGAP, 0: DIEP) as an explanatory variable and were fit to control for potential confounding factors such as age, race, BMI, and reoperation history. Statistical significance level of 0.05 was employed for 2-sided tests of the results, and analysis was performed using Stata11 (StataCorp, College Station, TX).

## RESULTS

Patient demographics collected from medical records are listed in Table 1. The mean age of study subjects was similar in the 2 groups: 46.1 ± 8.1 years (range, 33–67 y) for the SGAP group and 49.3 ± 10.7 years (range, 19–67 y) for the DIEP group ($P = 0.29$). The average BMI was higher in the DIEP group 30.7 ± 6.3 kg/m$^2$ (range, 20.8–42.0 kg/m$^2$) than the SGAP group 23.1 ± 3.0 kg/m$^2$ (range, 18.6–30.6 kg/m$^2$) ($P = 0.0001$), and the average interval between the reconstructive surgery and questionnaire administration was similar for both groups: 84 ± 20 weeks (range, 47–119 wk) for the SGAP group and 86 ± 20 weeks (range, 42–114 wk) for the DIEP group ($P = 0.85$). Proportions of patients reporting diabetes, hypertension, and smoking in the past 12 months were similar in the 2 groups.

A summary of complications related to reconstruction surgery is shown in Table 2. There were more patients in the SGAP group who had a seroma during the postoperative period than the DIEP group ($P = 0.06$); however, there was no difference in proportions of patients with a hematoma, infection, or reoperation after reconstruction. The seromas of all 3 SGAP patients eventually resolved and

**Table 1. Baseline Characteristics**

| | SGAP ($n = 17$) | DIEP ($n = 26$) | *P* |
|---|---|---|---|
| Age | 46.1 ± 8.1 | 49.3 ± 10.7 | 0.29 |
| BMI | 23.1 ± 3.0 | 30.7 ± 6.3 | 0.0001 |
| Follow-up (wk) | 84 ± 20 | 86 ± 20 | 0.85 |
| Smoking (%) | 5.9 | 7.7 | 1.00 |
| Diabetes (%) | 0 | 3.8 | 1.00 |
| Hypertension (%) | 11.8 | 19.2 | 0.69 |

did not require reoperation. Of the 5 reoperations performed, 3 were due to hematomas and 2 involved debridement of marginal necrotic tissue. No complications were noted after the reoperations.

The mean total LEFS corresponding to time 1 and time 2 were similar between SGAP and DIEP patients and are shown in Table 3. The minimum detectable change was 9 scale points and the mean overall difference was 4.3 ($P = 0.66$) and 0.4 points ($P = 0.95$) at 2 months and the time of survey, respectively, thus both differences were neither clinically nor statistically significant.

A summary of multivariate regression results of selected individual questions is shown in Table 4. Analysis of individual LEFS questions suggested that patients who underwent SGAP reconstruction rated their "usual hobbies, recreational or sporting activities" significantly more difficult than patients who underwent DIEP reconstruction after controlling for age, race, BMI, and reoperation history ($P = 0.021$). Regardless of the length of time since their operation, patients who underwent SGAP reconstruction also had more difficulty in performing the following activities than DIEP patients: "usual work, housework, or school activities" ($P = 0.015$), "squatting" ($P = 0.023$), "performing heavy activities" ($P = 0.045$), "walking for a mile" ($P = 0.006$), "going up or down 10 stairs" ($P = 0.015$), "sitting for 1 hour" ($P = 0.019$), "running on even ground" ($P = 0.006$), "running on uneven ground" ($P = 0.018$), "making sharp turns while running fast" ($P = 0.021$), and "hopping" ($P = 0.041$) after controlling for age, race, BMI, and reoperation history.

Multivariate analysis of the 14 supplemental questions (Table 5) suggested that SGAP patients "strongly agreed" more than DIEP patients that their legs or buttocks fatigued more easily at some point since their surgery ($P < 0.001$) and on the date of the survey ($P = 0.008$). Also, compared to DIEP patients, SGAP patients more "strongly agreed" that they experienced new pain at some point since their surgery ($P < 0.001$) and also experienced pain in their buttocks and legs on the date of the survey ($P < 0.001$). All other questions in the supplemental section evaluating gait and balance were found not to be significant.

**Table 2. Complications**

| | SGAP ($n = 17$) | DIEP ($n = 26$) | *P* |
|---|---|---|---|
| Reoperations (%) | 11.8 | 7.7 | 1.00 |
| Seroma (%) | 17.6 | 0 | 0.06 |
| Hematoma (%) | 17.6 | 7.7 | 0.28 |
| Infection (%) | 17.6 | 11.5 | 1.00 |

**Table 3. Total Lower Extremity Functional Scores at Time 1 and Time 2**

| | SGAP ($n = 17$) | DIEP ($n = 26$) | |
|---|---|---|---|
| **Total LEFS** | **Mean ± SD** | **Mean ± SD** | ***P*** |
| Time 1 | 55 ± 21 | 59 ± 19 | 0.66 |
| Time 2 | 73 ± 13 | 74 ± 11 | 0.95 |

## DISCUSSION

SGAP reconstruction has increased in popularity since it was first introduced 2 decades ago. However, the procedure is technically challenging and many reconstructive microsurgeons have limited experience operating within this complex donor site. Furthermore, little is known regarding the long-term surgical complications. Therefore, this study aims to investigate possible gait and ambulation complications to allow microsurgeons to accurately educate their patients and anticipate potential ambulatory complications that may arise as a result of SGAP flap surgery.

Reported disadvantages of SGAP flap surgery such as contour defects and loss of padding or contour have been mentioned in the literature.[4,7,11] Rates of donor-site complications such as seroma and flap-failure rate have also been documented, but there have been no reports in the literature indicating lower ex-

**Table 4. Multivariate Regression Results of Selected LEFS Questions**

| | Reconstruction (SGAP vs DIEP) | | |
|---|---|---|---|
| | **β** | **95% Confidence Interval** | ***P*** |
| Any of your usual work, housework, or school activities | −0.65* | −1.16 to −0.13 | 0.015 |
| Your usual hobbies, recreational or sporting activities | −0.79* | −1.45 to −0.12 | 0.021 |
| Squatting | −0.68* | −1.27 to 0.10 | 0.023 |
| Performing heavy activities around your home | −0.60* | −1.18 to −0.01 | 0.045 |
| Walking a mile | −1.01** | −1.28 to −0.12 | 0.006 |
| Going up or down 10 stairs (1 flight) | −0.72* | −1.29 to −0.15 | 0.015 |
| Sitting for 1 h | −0.70* | −1.25 to −0.07 | 0.019 |
| Running on even ground | −1.04** | −1.76 to −0.32 | 0.006 |
| Running on uneven ground | −0.95* | −1.73 to −0.17 | 0.018 |
| Making sharp turns while running fast | −0.92* | −1.70 to −0.14 | 0.021 |
| Hopping | −0.82* | −1.61 to −0.04 | 0.041 |

Multivariate regression model controlling for age, BMI, race, and reoperation history.
*$0.01 < P < 0.05$; **$P \leq 0.01$.

**Table 5. Multivariate Regression Results of Selected Supplemental Questions**

| | Reconstruction (SGAP vs DIEP) | | |
|---|---|---|---|
| | β | 95% Confidence Interval | *P* |
| Today, my buttocks or legs fatigue easier | 1.60 | 0.44–2.77 | 0.008 |
| At some point since my surgery, my buttocks or legs fatigued easier | 2.47 | 1.39–3.56 | 0.000 |
| Today, I experience pain in my buttocks or legs | 1.59 | 0.84–2.34 | 0.000 |
| At some point since my surgery, I experienced new pain in my buttocks or legs | 2.09 | 1.22–2.95 | 0.000 |

Multivariate regression model controlling for age, BMI, race, and reoperation history.

tremity deficits following SGAP reconstruction.[4,7,11] Furthermore, application of tools to evaluate donor-site morbidity using patient-reported outcomes after autologous tissue breast reconstruction have rarely been utilized. One study reported posterior thigh hypoesthesia in teenagers who had inferior gluteal flap reconstruction, but there were only 6 patients in the study with no control group.[12] Two studies, one with a validated questionnaire and one without a validated questionnaire, have assessed functional limitations between DIEP and transverse rectus abdominis muscle reconstruction[13,14] but no study has compared DIEP and SGAP reconstruction patients.

Lower extremity donor sites from other types of flap harvest have been shown to have functional deficits following flap harvest. For example, anterolateral thigh flaps have been correlated with decreased sensibility in the donor thigh,[15,16] and one study even reported that 9% of patients in their study walked with a limp postoperatively.[16] Sbitany et al[17] reported a 21% difference in isometric knee strength following rectus femoris harvest although a similar difference was found in the control group. The SGAP flap limits its morbidity by utilizing the perforator dissection technique, and although no muscle is harvested, flap dissection requires that the gluteus muscle be partially divided and retracted potentially causing injury to the muscle and potential for problems with gait.

In this study, bilateral SGAP patients were found to have no difference in overall lower extremity function scores compared to bilateral DIEP patients after reconstruction. However, compared to DIEP patients, SGAP patients had greater difficulty in performing 11 specific activities after their reconstruction. Interestingly, the 11 significant activities out of the 20 items listed in the LEFS all involved more intense strenuous activity involving the buttocks compared to the remaining activities. SGAP patients also reported greater fatigue and pain in their lower extremity on the date of the survey compared to DIEP patients. The presence of some complications even on long-term follow-up suggests some significant chronic morbidity of the donor site. Therefore, our results suggest that difficulty in performing strenuous activity involving the lower extremity and persistent donor-site pain and lower extremity fatigue can occur for some patients.

There are several limitations to our pilot study. First, this was a retrospective analysis, which can lead to inherent patient selection bias. This was seen in the statistically significant difference in BMI between the 2 groups, which we attempted to control for by using multivariate analysis. Second, we only investigated patients who had undergone bilateral autologous tissue reconstruction; this excludes unilateral reconstructions, and thus is not representative of our entire population of patients. Further studies on patients with unilateral reconstruction are needed to have broader implications for SGAP reconstruction. Third, data were collected through the subjective evaluation of lower extremity function by patients themselves with no baseline recorded before their reconstructive surgery. A multicenter study, larger sample size, and prospective approach that includes a preoperative LEFS and multiple postoperative LEFS surveys at standard time points are warranted to research this phenomenon further.

## CONCLUSIONS

This study provides evidence of patient-reported donor-site morbidity after SGAP reconstruction. Although there were no statistical differences in the total LEFSs between SGAP and DIEP patients, there were specific activities that were significantly more difficult for SGAP patients to perform and SGAP patients had issues with fatigue and pain on long-term follow-up. Although not specifically analyzed in this study, we propose that patients undergoing SGAP reconstruction should be educated about the possibility of gait issues during the recovery period and pain and fatigue in their lower extremities for an extended period of time. Extrapolating from our findings, we believe that it is logical to recommend the use of physical therapy during the early postoperative period to potentially mitigate the onset or severity of these reported difficulties.

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### Appendix 1. Lower Extremity Functional Scale

| | Extremely Difficult or Unable to Perform | Quite a Bit of Difficulty | Moderate Difficulty | A Little Bit of Difficulty | No Difficulty |
|---|---|---|---|---|---|
| a. Any of your usual work, housework, or school activities | 0 | 1 | 2 | 3 | 4 |
| b. Your usual hobbies, recreational or sporting activities | 0 | 1 | 2 | 3 | 4 |
| c. Getting into or out of the bath | 0 | 1 | 2 | 3 | 4 |
| d. Walking between rooms | 0 | 1 | 2 | 3 | 4 |
| e. Putting on your shoes or socks | 0 | 1 | 2 | 3 | 4 |
| f. Squatting | 0 | 1 | 2 | 3 | 4 |
| g. Lifting an object, like a bag of groceries from the floor | 0 | 1 | 2 | 3 | 4 |
| h. Performing light activities around your home | 0 | 1 | 2 | 3 | 4 |
| i. Performing heavy activities around your home | 0 | 1 | 2 | 3 | 4 |
| j. Getting into or out of a car | 0 | 1 | 2 | 3 | 4 |
| k. Walking 2 blocks | 0 | 1 | 2 | 3 | 4 |
| l. Walking a mile | 0 | 1 | 2 | 3 | 4 |
| m. Going up or down 10 stairs (1 flight) | 0 | 1 | 2 | 3 | 4 |
| n. Standing for 1 h | 0 | 1 | 2 | 3 | 4 |
| o. Sitting for 1 h | 0 | 1 | 2 | 3 | 4 |
| p. Running on even ground | 0 | 1 | 2 | 3 | 4 |
| q. Running on uneven ground | 0 | 1 | 2 | 3 | 4 |
| r. Making sharp turns while running fast | 0 | 1 | 2 | 3 | 4 |
| s. Hopping | 0 | 1 | 2 | 3 | 4 |
| t. Rolling over in bed | 0 | 1 | 2 | 3 | 4 |
| Column totals: | | | | | |

Score: _____/80.
Error (single measure): ±5 scale points.
Minimum detectable change: 9 scale points.
Minimal clinically important difference: 9 scale points.

### Appendix 2. Supplementary Gait Questions

| How much do you agree with the following: | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
|---|---|---|---|---|---|
| 1. Today, my buttocks or legs fatigue easier | 0 | 1 | 2 | 3 | 4 |
| 2. At some point since my surgery, my buttocks or legs fatigued easier | 0 | 1 | 2 | 3 | 4 |
| 3. Today, I feel as though I have less balance | 0 | 1 | 2 | 3 | 4 |
| 4. At some point since my surgery, I felt as though I had less balance | 0 | 1 | 2 | 3 | 4 |
| 5. Today, I experience pain in my buttocks or legs | 0 | 1 | 2 | 3 | 4 |
| 6. At some point since my surgery, I experienced new pain in my buttocks or legs | 0 | 1 | 2 | 3 | 4 |
| 7. Today I limp as a result of my reconstruction | 0 | 1 | 2 | 3 | 4 |
| 8. At some point since my surgery, I developed a new limp | 0 | 1 | 2 | 3 | 4 |
| 9. I walk just as fast since my surgery | 0 | 1 | 2 | 3 | 4 |
| 10. My balance is just as good since my surgery | 0 | 1 | 2 | 3 | 4 |
| 11. My endurance is just as good since my surgery | 0 | 1 | 2 | 3 | 4 |
| 12. My surgery has affected the way I walk | 0 | 1 | 2 | 3 | 4 |
| 13. My activity level has decreased since my surgery | 0 | 1 | 2 | 3 | 4 |
| 14. I had problems with the way I walked before surgery | 0 | 1 | 2 | 3 | 4 |

## REFERENCES


1. Allen RJ, Tucker C Jr. Superior gluteal artery perforator free flap for breast reconstruction. *Plast Reconstr Surg.* 1995;95:1207–1212.
2. Shaw WW. Superior gluteal free flap breast reconstruction. *Clin Plast Surg.* 1998;25:267–274.
3. Shaw WW. Breast reconstruction by superior gluteal microvascular free flaps without silicone implants. *Plast Reconstr Surg.* 1983;72:490–501.
4. LoTempio MM, Allen RJ. Breast reconstruction with SGAP and IGAP flaps. *Plast Reconstr Surg.* 2010;126:393–401.
5. Rad AN, Flores JI, Prucz RB, et al. Clinical experience with the lateral septocutaneous superior gluteal artery perforator flap for autologous breast reconstruction. *Microsurgery* 2010;30:339–347.
6. Granzow JW, Levine JL, Chiu ES, et al. Breast reconstruction with perforator flaps. *Plast Reconstr Surg.* 2007;120:1–12.

7. Baumeister S, Werdin F, Peek A. The sGAP flap: rare exception or second choice in autologous breast reconstruction? *J Reconstr Microsurg*. 2010;26:251–258.
8. Binkley JM, Stratford PW, Lott SA, et al. The Lower Extremity Functional Scale (LEFS): scale development, measurement properties, and clinical application. North American Orthopaedic Rehabilitation Research Network. *Phys Ther*. 1999;79:371–383.
9. Rosson GD, Shridharani SM, Magarakis M, et al. Three-dimensional computed tomographic angiography to predict weight and volume of deep inferior epigastric artery perforator flap for breast reconstruction. *Microsurgery* 2011;31:510–516.
10. Rosson GD, Williams CG, Fishman EK, et al. 3D CT angiography of abdominal wall vascular perforators to plan DIEAP flaps. *Microsurgery* 2007;27:641–646.
11. Guerra AB, Metzinger SE, Bidros RS, et al. Breast reconstruction with gluteal artery perforator (GAP) flaps: a critical analysis of 142 cases. *Ann Plast Surg*. 2004;52:118–125.
12. Dupéré S, Bergeron L, Bortoluzzi P, et al. Donor-site morbidity of the inferior gluteal musculocutaneous flap for breast reconstruction in teenagers. *Ann Plast Surg*. 2007;59:617–620.
13. Blondeel N, Vanderstraeten GG, Monstrey SJ, et al. The donor site morbidity of free DIEP flaps and free TRAM flaps for breast reconstruction. *Br J Plast Surg*. 1997;50:322–330.
14. Schaverien MV, Perks AG, McCulley SJ. Comparison of outcomes and donor-site morbidity in unilateral free TRAM versus DIEP flap breast reconstruction. *J Plast Reconstr Aesthet Surg*. 2007;60:1219–1224.
15. Townley WA, Royston EC, Karmiris N, et al. Critical assessment of the anterolateral thigh flap donor site. *J Plast Reconstr Aesthet Surg*. 2011;64:1621–1626.
16. Kimata Y, Uchiyama K, Ebihara S, et al. Anterolateral thigh flap donor-site complications and morbidity. *Plast Reconstr Surg*. 2000;106:584–589.
17. Sbitany H, Koltz PF, Girotto JA, et al. Assessment of donor-site morbidity following rectus femoris harvest for infrainguinal reconstruction. *Plast Reconstr Surg*. 2010;126:933–940.