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Reconstructive

A Multicenter Comparison of Reconstruction Strategies after Wide Excision for Severe Axillary Hidradenitis Suppurativa

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Background: An appropriate reconstruction strategy after wide excision for severe cases of axillary hidradenitis suppurativa (HS) is important to optimize outcomes, but no consensus exists on which reconstruction strategy should be preferred.
Objective: Evaluate which reconstruction strategy after wide excision in patients with severe axillary HS is associated with improved outcomes in terms of recurrence rate, complications, post-reconstruction limb function, aesthetics, and patient satisfaction.
Methods: Retrospective analysis between 2008 and 2018 of wide excision and reconstruction by primary closure (PC), secondary intention healing (SIH), split thickness skin grafts (STSG), or fasciocutaneous flaps (FCF). The primary endpoint was the rate of recurrence during follow-up.
Results: A total of 107 surgical interventions were performed on 54 patients. The overall recurrence rate was 31.8% after a median follow-up of 30 months, with a significant difference between PC (48%), SIH (16%), STSG (29%), and FCF (10%) ($P = 0.03$). Surgical complications requiring reoperation occurred in 2% after PC, 0% after SIH, 13% after STSG, and 15% after FCF ($P = 0.11$). The median score regarding function, aesthetics, and satisfaction after all interventions was 17 out of 20 points, but the score was lower after FCF than PC, SIH, and STSG ($P = 0.03$).
Conclusions: Reconstruction by PC should be reserved for patients with limited HS lesions, whereas FCF was most effective in avoiding recurrence, but was associated with unfavorable short-term results and patient-reported outcomes regarding function and aesthetics. FCF should generally be reserved for patients with recurrent, severe HS comprising an extensive surface of the axillary skin. *(Plast Reconstr Surg Glob Open 2019;7: e2361; doi: 10.1097/GOX.0000000000002361; Published online 30 August 2019.)*

INTRODUCTION

For patients with severe HS, wide excision with complete removal of the affected skin, underlying adipose tissue and adequate free margins (1–3 cm) is reported to have the highest success.[1] However, although reconstruction after wide excision is crucial for cure, aesthetics, and function, there is no consensus on the optimal method. There is a lack of high-quality evidence and most of the available, usually small single-center studies, analyze their results combining outcomes after surgery in multiple anatomic locations. This could lead to bias, given recurrence rates may differ between the affected areas.[2] Moreover, differentiating between anatomic locations is crucial because each location possesses different anatomical features and functions that must be considered when choosing the reconstruction strategy.[3,4]

In this study, we evaluated different reconstruction strategies after wide excision in patients with severe axillary HS,

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to determine the recurrence rate, complications, limb function, aesthetics, and patient satisfaction.

METHODS

Study Design and Subjects

This is a multicenter, retrospective analysis of patients who underwent wide excision and reconstruction surgery for severe axillary HS between January 2008 and January 2018 at two Plastic and Reconstructive Surgery departments in Amsterdam, The Netherlands: Amsterdam University Medical Center (Amsterdam UMC) location AMC and OLVG.

Data Collection and Follow-up

Data were obtained through medical charts. In May 2018, telephone interviews were conducted. The follow-up period was defined as the period between the surgical intervention and telephone interview or the last outpatient visit.

Patient and Interventional Characteristics

Disease severity was defined according to the Hurley staging system. Disease activity outside the axilla was also collected. Prior medical and surgical treatment were noted. The most radical treatment was listed in patients with multiple prior surgical procedures. Disease duration was the period of active disease since the first diagnosis.

Wide excision was performed under general anesthesia according to a premarked pattern. If deemed necessary, the excision was enlarged during surgery, to ensure all the affected tissue was excised.

The reconstruction method was chosen through a shared decision-making process, and included primary wound closure (PC), secondary intention healing (SIH), meshed split thickness skin grafts (STSG), or (local) fasciocutaneous flaps (FCFs). Negative pressure wound therapy (NPWT) was occasionally used for SIH or as preparation and fixation of STSGs. Immobilization of the arm was not universally advised.

Outcomes and Definitions

The primary end point was the recurrence rate, defined as a postoperative relapse. Remission time was reported as the postoperative period during which no new inflammatory lesions were observed.

Secondary end points consisted of surgical complications, postoperative length-of-stay, the number of outpatient department visits, and healing time. Wound infections were categorized into (superficial) infections and severe infections or sepsis. Bleeding, wound dehiscence, and flap necrosis were noted if reoperation was required.

Graft failure was defined as a take of less than 50% or need for reoperation. Healing time was the period between surgery and wound closure or discharged from follow-up.

Patient-reported outcomes included shoulder movement, pain, satisfaction with treatment, willingness to undergo surgery again, and appearance. Patients graded each outcome on a 4-point scale, for each treated axilla. Postoperative physiotherapy was also noted (**See appendix, Supplemental Digital Content 1**, which displays the questionnaire for patient-reported outcomes, ***http://links.lww.com/PRSGO/B165***).

Statistical Analysis

Data were reported per axilla, also in patients with bilateral procedures. Categorical data are presented as proportions and compared using the Chi-square test or Fisher's exact test, where appropriate. Continuous data are reported as mean ± SD or median (interquartile range [IQR]), depending on the normality of the distribution. Homogeneity of variance was assessed by the (nonparametric) Levene's test. Considering the difference in length of follow-up, the primary end point of recurrence was assessed with Kaplan–Meier estimates and compared using a log-rank test. Normally distributed data were compared using the unpaired *t*-test (2 groups), one-Way ANOVA (>2 groups), and Welch's ANOVA (>2 groups with no homogeneity of variance). Not-normally distributed data were compared using the Mann–Whitney *U* test (2 groups) or the Kruskall–Wallis test (>2 groups). A two-sided *P* value <0.05 was considered to be statistically significant. Analyses were conducted with SPSS (IBM SPSS Statistics, Version 25).

RESULTS

Patient and Procedural Characteristics

A total of 54 patients underwent wide excision with reconstruction (Table 1). Mean age at presentation was 36.6 ± 12.3 years, 61% were female. The median duration of disease before surgery was 7 years (IQR: 3–18 years). All patients had previously received therapy consisting of systemic antibiotics and surgery at different anatomical locations.

A total of 107 operations were performed (Table 2). Hurley stage II and III were present in 53 locations (50%) and 54 locations (50%), respectively. Previous surgical interventions were performed in 64 axillae (60%). The median size of defects after wide excision was 41 cm^2 (IQR: 21–68 cm^2). The reconstruction methods were PC in 41%, SIH in 11%, STSG in 29%, and FCF in 19%. Postoperative NPWT was applied in 24%. In only 12% of the excisions was it decided to perform a two-stage reconstruction.

Reconstruction Groups

There were a number of differences in baseline characteristics between the reconstruction groups. Patients in the FCF group had a higher Hurley stage and had significantly more risk factors (Table 1). The mean total number of other locations with disease activity was highest in the SIH group. The median defect size was statistically significantly smaller in the PC and SIH groups compared with the STSG and FCF groups. Postoperative NPWT was used less frequently in the STSG group.

Table 1. Patient Characteristics

Characteristic	Patients (n = 54)	Reconstructions Groups				
		PC (n = 44)	SIH (n = 12)	STSG (n = 31)	FCF (n = 20)	*P*
Female gender	61% (32/54)	73 (32/44)	41% (5/12)	52% (16/31)	50% (10/20)	0.094
Mean age	36.6±12.3 (54)	34±11 (44)	36±18 (12)	35±13 (31)	37±13 (20)	0.856
Smoking	69% (37/54)	68% (30/44)	58% (7/12)	65% (20/31)	95% (19/20)	0.038
Obesity (BMI > 30 kg/m^2)	32% (17/54)	36% (16/44)	0% (0/12)	36% (11/31)	55% (11/20)	0.011
Hypertension	15% (8/54)	9% (4/44)	0% (0/12)	19% (6/31)	30% (6/20)	0.066
Diabetes mellitus type 2	9% (5/54)	5% (2/44)	8% (1/12)	13% (4/31)	15% (3/20)	0.407
Crohn's disease	4% (2/54)	5% (2/44)	0% (0/12)	0% (0/31)	0% (0/20)	0.759
Mean total number of risk factors*	1.2±1.0 (54)	1.1±0.8 (44)	0.7±0.7 (12)	1.3±1.2 (31)	1.9±1.2 (20)	0.004
Bilateral axial disease	63% (34/54)	75% (33/44)	83% (10/12)	90% (28/31)	80% (16/20)	0.428
Other locations						
Mean total	1.5±1.0 (54)	1.6±1.0 (44)	2.2±1.0 (12)	1.3±1.0 (31)	1.8±0.8 (20)	0.040
None	17% (9/54)	9% (4/44)	0% (0/12)	23% (7/31)	10% (2/20)	0.206
Inguinal	74% (40/54)	82% (36/44)	92% (11/12)	74% (23/31)	85% (17/20)	0.644
Anogenital	44% (24/54)	46% (20/44)	83% (10/12)	19% (6/31)	65% (13/20)	<0.001
Other	22% (12/54)	25% (11/44)	25% (3/12)	29% (9/31)	30% (6/20)	0.965
Previous medical treatment						
Systemic antibiotics	100% (54/54)	100% (54/54)	100% (54/54)	100% (54/54)	100% (54/54)	N/A
Biologicals	32% (17/54)	23% (10/44)	33% (4/12)	45% (14/31)	45% (9/20)	0.147
Corticosteroids	7% (4/54)	18% (8/44)	0% (0/12)	13% (4/31)	10% (2/20)	0.493
Previous surgical interventions						
Median total	2, 1–2 (54)	3, 1–4 (44)	2, 2–2 (12)	2, 2–3 (31)	2, 2–3 (20)	0.331

Categorical data are expressed as % (n/N). Continuous data are expressed as mean±SD or median, IQR.
*Smoking, obesity, hypertension, diabetes mellitus type 2, and Crohn's disease.

Table 2. Procedural Characteristics

Characteristic	Reconstructions (n = 107)	Reconstructions Groups				
		PC (n = 44)	SIH (n = 12)	STSG (n = 31)	FCF (n = 20)	*P*
Disease duration in years*	7, 3–18 (107)	6, 5–18 (44)	8, 3–20 (12)	7, 3–11 (31)	10, 3–21 (20)	0.816
Right axilla	50% (53/107)	36% (16/44)	67% (8/12)	55% (17/31)	60% (12/20)	0.133
Hurley stage						
II	50% (53/107)	77% (34/44)	67% (8/12)	32% (10/31)	5% (1/20)	<0.001
III	50% (54/107)	23% (10/44)	33% (4/12)	68% (21/31)	95% (19/20	
Previous surgical intervention						
None	40% (43/107)	32% (14/44)	75% (9/12)	42% (13/31)	35% (7/20)	0.393
Incision	17% (18/107)	14% (6/44)	8% (1/12)	19% (6/31)	25% (5/20)	
Deroofing	7% (7/107)	5% (2/44)	0% (0/12)	7% (2/31)	15% (3/20)	
Wide excision	23% (25/107)	32% (14/44)	17% (2/12)	19% (6/31)	15% (3/20)	
Perioperative medical treatment						
None	45% (48/107)	50% (22/44)	25% (3/12)	52% (16/31)	35% (7/20)	0.303
Oral antibiotics	33% (35/107)	32% (14/44)	67% (8/12)	23% (7/31)	30% (6/20)	0.060
IV antibiotics	18% (19/107)	16% (7/44)	0% (0/12)	16% (5/31)	35% (7/20)	0.090
Biologicals	14% (15/107)	7% (3/44)	25% (3/12)	29% (9/31)	0% (0/20)	0.004
Corticosteroids	9% (10/107)	11% (5/44)	0% (0/12)	10% (3/31)	10% (2/20)	0.838
Defect size after wide excision, in cm^2	41, 6–68 (87)	21, 11–30 (28)	24, 20–42 (11)	65, 47–80 (28)	66, 34–110 (20)	<0.001
Postoperative NPWT applied	24% (26/107)	5% (2/44)	17% (2/12)	52% (16/31)	30% (6/20)	<0.001

Categorical data are expressed as % (n/N). Continuous data are expressed as mean±SD or median, IQR.
*Until intervention.
IV = intravenous.

Primary End Point Results

Median follow-up was 30 (IQR: 6–68) months, after which the cumulative recurrence rate was 31.8%. The recurrence rate was 47.7% after 36 (IQR: 8–73) months in the PC group, 16.7% after 52 (IQR: 9–68) months in the SIH group, 29.0% after 46 (IQR: 8–68) months in the STSG group, and 10.0% after 11 (IQR: 4–24) months in the FCF group ($P = 0.03$) (Fig. 1). The median time until a recurrence occurred was 3 (IQR: 2–6) months. The median remission time was not statistically significantly different between the reconstruction groups ($P = 0.13$).

Nineteen locations (18%) required wide re-excision under general anesthesia, 9 locations (9%) in which recurrence occurred were treated conservatively, and six locations (6%) required local re-excision under local anesthesia.

Surgical Complications and Wound Healing

Wound infections were common and occurred in 9% after surgical intervention (Table 3). Patients in the FCF group required more reoperations because of complications (15%) as compared with PC (2%), SIH (0%), and STSG (13%), although this was not statistically significant ($P = 0.11$). Reoperation was required for bleeding in 1 case, wound dehiscence in 2 cases, graft failure in 4 cases, and for flap necrosis in 1 case. Other cases of wound healing problems were resolved through SIH. Hypergranulation occurred in 35% of patients.

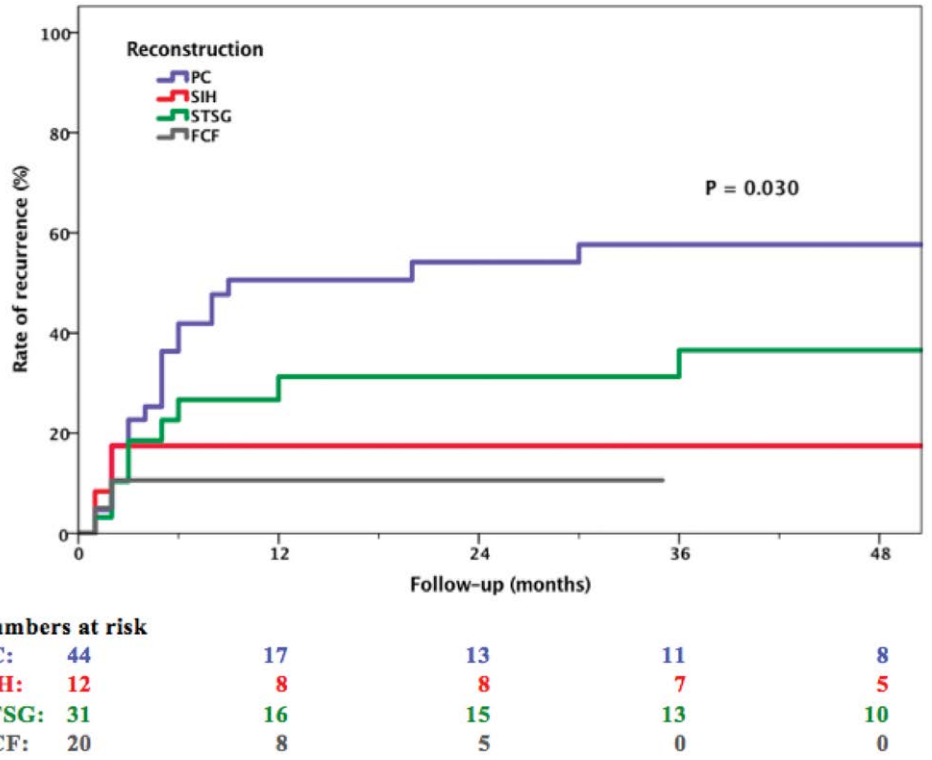

Fig. 1. Recurrence during follow-up after wide excision and reconstruction.

Table 3. Postoperative Complications

Complication	Reconstructions (n = 107)	Reconstruction Groups				
		PC (n = 44)	SIH (n = 12)	STSG (n = 31)	FCF (n = 20)	*P*
Wound infection Requiring oral antibiotics	8% (9/107)	7% (3/44)	0%	7% (2/31)	20% (4/20)	0.299
Causing sepsis	1% (1/107)	0%	0%	3% (1/31)	0%	0.589
Bleeding	1% (1/107)	0%	0%	0%	5% (1/20)	0.229
Wound dehiscence	5% (5/107)	7% (3/44)	—	—	10% (2/20)	N/A
Flap necrosis	1% (1/107)	—	—	—	5% (1/20)	N/A
STSG failure	4% (4/107)	—	—	13% (4/31)	—	N/A
Reoperation*	7% (8/107)	2% (1/44)	0%	13% (4/31)	15% (3/20)	0.107
Hypergranulation	35% (37/107)	25% (11/44)	50% (6/12)	45% (14/31)	30% (6/20)	0.193

*Due to a complication (eg, infection, bleeding, wound dehiscence, flap necrosis, and graft failure), not due to recurrence.

The median length of hospital stay was 1 day (IQR: 1–2 days), the median number of outpatient department visits was 4 (IQR: 2–6), and the median healing time was 6 weeks (IQR: 4–10 weeks) (Fig. 2). Patients that underwent reconstruction by PC had significantly shorter hospital stay, less outpatient department visits, and shorter healing time ($P < 0.0083$).

Patient-reported Outcomes

The questionnaire was completed by 37 patients (69%) who had 58 axillae treated (interventions) (54%) (**See appendix, Supplemental Digital Content 2**, which displays the patient-reported outcomes per reconstruction group, ***http://links.lww.com/PRSGO/B166***).

Shoulder movement was considered good or very good in 49 axillae (86%) (Fig. 3A) and physiotherapy was performed on 17 axillae (29%). Pain reported as "currently never" or "sometimes present" was reported in 51 axillae (88%) and was significantly higher in the FCF group ($P = 0.03$). Patients were satisfied or very satisfied about 50 axillae (86%). Patients were certain or very certain in their willingness to undergo surgery again after 45 interventions (78%). Appearance of the operated axilla was scored as very attractive or attractive after 28 interventions (48%). The median score after all interventions was 17 points out of 20 (IQR: 14–18 points) and was significantly lowest in the FCF group ($P = 0.03$) (Fig. 3B).

DISCUSSION

In this analysis of 107 wide excisions with reconstruction for Hurley stage 2 or 3 HS, the recurrence rate was 31.8% after a median of 30 months of follow-up. The high-

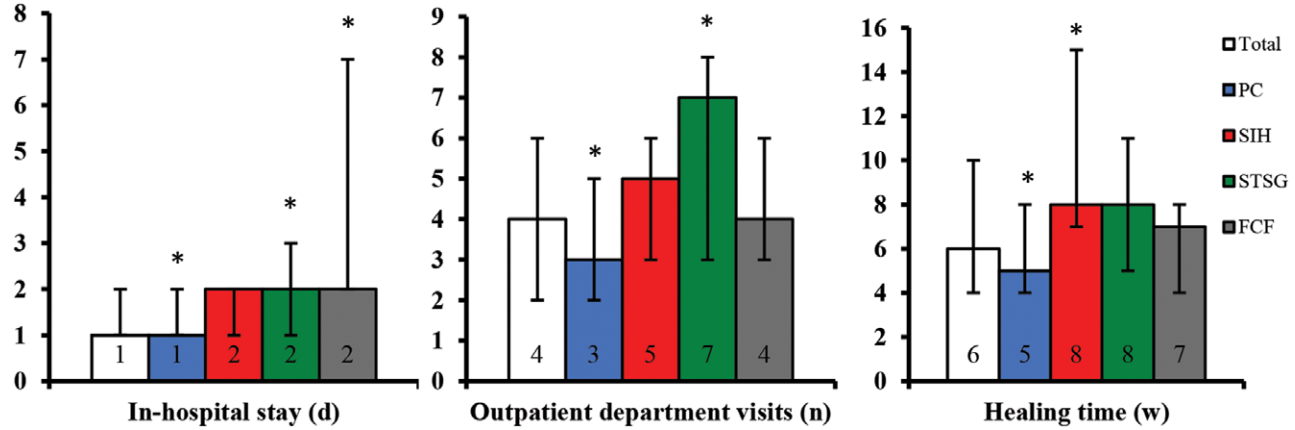

Fig. 2. Hospital stay, outpatient department visits, and healing time. *Significant difference in pairwise comparison using Dunn's procedure with a Bonferroni correction ($P < 0.0083$). Data are presented as median with error bars corresponding to IQRs.

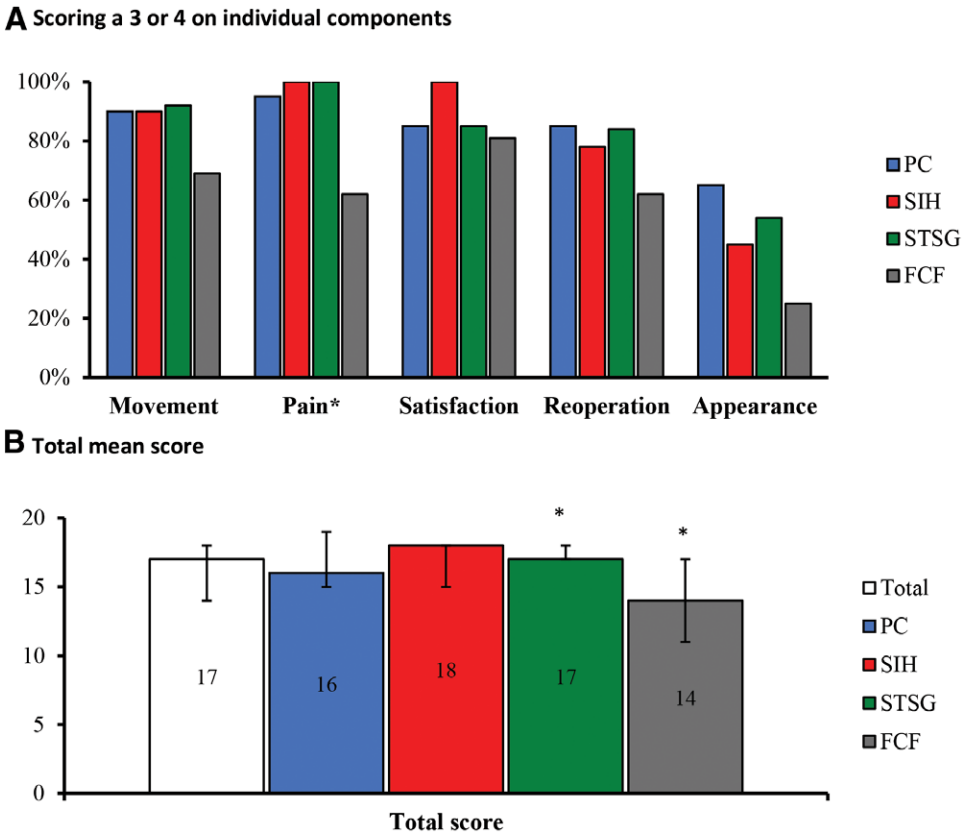

Fig. 3. Patient-reported outcomes. A, Scoring was done on a 4-point scale (minimum score 5–maximum score 20), where a score 1 indicated the worst possible outcome and 4 indicated the best possible outcome. B, Data are presented as median with error bars corresponding to IQRs. *Significant difference between the reconstruction groups ($P = 0.03$).

est recurrence rate occurred after wide excision with PC, whereas the lowest recurrence rate was among patients that underwent reconstruction with FCF, despite having the most advanced disease severity and more comorbidities. The overall surgical complication rate was 11% and there was no difference between reconstruction strategies. Patients scored 17 out of 20 with regard to function and aesthetics, but this was significantly lower after FCF. To our knowledge, this is one of the largest studies reporting outcomes after wide excision specifically focusing on severe axillary HS. It is also one of few studies comparing multiple reconstruction methods.

Similar to other studies, our patients had a history of chronic disease with long-term medical treatment and multiple (local) interventions before referral to our department.[5,6] At the time of referral, all patients were in

Hurley stage II and III and often displayed disease activity in multiple other locations. Most patients had multiple risk factors including smoking, obesity, and diabetes, which have been associated with suboptimal outcomes in HS.[6]

Recurrence rates of 0% up to 70% have been reported in the literature, with a recent meta-analysis pooling these results reporting a 13% recurrence rate after wide excision.[1,5,7–9] Some studies have reported recurrences occurring only within limited margins of the scar due to irradical excision or after a short follow-up period.[3,6] Indeed, the divergent results can be explained by the significant heterogeneity among studies with respect to follow-up length, use of concurrent medical therapies, extent of the excision, reconstruction modalities, definition of recurrence, all of which make comparison of results complicated.[1,10] Moreover, studies have included patients with heterogenicity in disease severity and location, with insufficient information on individual patients with severe axillary HS.[2] Differentiating between anatomic locations is crucial given the fact that each location possesses different anatomy, including the distribution of apocrine glands that affect the extent of the excision and function, such as mobility, that are important factors when choosing the best reconstruction method. Our recurrence rate of 32% at a median of 30 months of follow-up after wide excision and reconstruction sets a benchmark for surgery for axillary disease among patients recurrent and advanced axillary HS.[11]

We found significant differences between the reconstruction groups. This may reflect the extent of the excision and reconstruction plan. The recurrence rate was highest after PC, potentially due to an inadvertent compromise in the excision margin to be able to facilitate PC, accompanied by entrapment of epithelial strands or debris[7,12,13]; the size of the excision was indeed smallest after PC. The defect size was also small when SIH was chosen, likely because the main drawback of SIH is the creation of a large open wound requiring prolonged wound care compared to PC. However, the risk of recurrence is lower. Of note, the amount of outpatient department visits after SIH were also largely comparable to the other reconstruction methods, likely because patients have experience in wound care and receive adequate community-based nursing.[14]

The defect size after excision was much larger before STSG or FCF reconstruction. These reconstruction options impose fewer restrictions in terms of defect size. Nevertheless, despite assuming more radical excision is associated with lower recurrence rates, STSG was associated with a high recurrence rate in our series. It has been reported that recurrences occur outside the STSG, in the skin surrounding the excision site, implying that recurrences occur mostly due to natural disease progression rather than irradical excision.[4] Some authors have discouraged the use of STSG in the axilla because the risk of contractures, donor site morbidity, and poor aesthetic results.[8,15] Contracture rates were not specifically reported in our series, but most patients (92%) scored their shoulder function as good or very good. Even though we experienced a relatively high recurrence rate after STSG, 85% of patients were still either satisfied or very satisfied with their outcomes and were willing to undergo the surgery again if necessary.

Ninety-five percentage of patients that underwent reconstruction with FCF were in Hurley stage 3, these patients also had the highest number of risk factors including diabetes mellitus type II and obesity, but FCF reconstruction resulted in the lowest recurrence rate. Moreover, there was a significantly higher complication rate (25% versus 8%–10% after other reconstructions) and frequent wound dehiscence (10%) contributing to a high rate of reoperation (15%). In addition to these factors, the longer hospital stays as compared with other reconstruction strategies and low scores on range of motion and appearance most likely contributed to the fact that we found FCF to be associated with the lowest median total patient-reported score (14 out of 20). Nevertheless, FCF with the Limberg transposition flap,[16] thoracodorsal artery perforator flap,[17] thin circumflex scapular artery perforator flap,[18] scapular island flap,[19] posterior arm fasciocutaneous flap,[20] and lattisimus dorsi flap[21] is increasingly being used after wide excision. Studies will be required to evaluate whether certain techniques are associated with improved outcomes as compared to the use of other flaps.

Our study has limitations due to its retrospective design. Despite being one of the largest cohorts on surgical treatment of severe axillary HS, statistical power was limited to detect significant differences between reconstruction groups because of low patient numbers as well as bias in the selection of the reconstruction. Moreover, the absolute number of recurrences that occurred was low and we were therefore not able to perform multivariable predictor analyses to correct for baseline differences between reconstruction groups. The patient-reported questionnaire used in our analysis was not validated and the response rate of 69% may have introduced bias.

In conclusion, among patients with long-term, Hurley stage 2 or 3 axillary HS, wide excision with reconstruction resulted in a recurrence rate of 31.8% after a median follow-up of 30 months. Our data suggest PC should be reserved for patients with limited HS lesions without compromising on the margin of excision, whereas FCF has the lowest recurrence but is associated lower patient satisfaction and should be used for patients with recurrent severe HS comprising an extensive surface of the axillary skin.

We believe our data support that the ideal treatment strategy should be to perform an excision without a predetermined reconstruction plan to ensure adequate removal of diseased tissue without compromising on excision margins. Prospective studies with predefined uniform outcomes are required to confirm this hypothesis and better understand which excision and reconstruction approaches are most appropriate for individual patients on the basis of anatomic features, extent of disease, and patient preferences.

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