



# Reconstruction of the Axillary Region after Excision of Hidradenitis Suppurativa: A Systematic Review

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## Abstract

**Introduction** Hidradenitis suppurativa (HS) is a chronic, debilitating, recurrent, auto-inflammatory disease of the pilosebaceous units of the skin. The axillary region is the most affected anatomical site and its reconstructive options include skin grafts, local random plasties, regional axial flaps, and regional perforator flaps. The main aim of this systematic review is to identify the best surgical technique for axillary reconstruction in the context of HS, in terms of efficacy and safety.

**Methods** We adhered to Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) throughout the whole review protocol build-up. The literature search was performed using MEDLINE, Embase, and Cochrane library databases, updated to March 2021. Quality was assessed for each study, through the National Institutes of Health Quality Assessment Tool.

**Results** A total of 23 studies were included in the final analysis. We reviewed a total of 394 axillary reconstructions in 313 patients affected by HS Hurley Stage II or III. Skin grafts were associated with the highest overall complication rate (37%), and highest rate of reconstruction failure (22%). Between thoraco-dorsal artery perforator flap, posterior arm flap, and parascapular flap, the latter showed fewer total complications, recurrences, and failures.

**Conclusion** Regional axial flaps should be considered as the best surgical approach in the management of advanced HS. The parascapular flap emerges as the most effective and safest option for axillary reconstruction. Local random flaps might be considered only for selected minor excisions, due to the higher risk of recurrence. The use of skin grafts for axillary reconstruction is discouraged.

## Keywords

- ▶ hidradenitis suppurativa
- ▶ axillary hidradenitis
- ▶ axillary reconstruction
- ▶ parascapular flap

## Introduction

Hidradenitis suppurativa (HS) is a chronic, debilitating, recurrent, inflammatory disease of the folliculo-pilo-sebaceous units of the skin, with an estimated prevalence

of 1 to 4% in the general population. The axillary, the perineal, and the inframammary regions appear to be frequently involved.<sup>1,2</sup> The chronic and recurrent formation of abscesses and sinus tracts worsens the quality of life of affected patients, with both physical and psychological

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consequences.<sup>3,4</sup> Disease activity is classified following the Hurley score.<sup>1</sup>

Medical therapy, including oral antibiotics or immunomodulating drugs, is usually the first-line treatment. Nevertheless, HS Hurley stage III usually presents with extensive cases refractory to the noninvasive therapies, requiring large excisions of the entire affected area,<sup>5</sup> with surgical margins extending beyond the clinical borders of disease activity.<sup>6</sup> While wide excisions offer a good treatment in the long term, the reconstruction of the excised area represents a challenge in the short term.

HS most commonly presents in the axillary region<sup>7</sup> and several reconstructive options have been proposed in the literature, including skin grafts, local random flap, regional axial flaps, regional perforator flaps, and secondary intention healing. The ideal reconstructive option should be thin, large, and pliable, to recreate the concavity of the axillary region without impairing the shoulder motion. Skin grafts are commonly large and thin; however, they generally lack elasticity and retract over time. Regional axial flaps or perforator flaps are large and pliable, but usually fail to recreate the concavity, ending up in bulky reconstructions. Local random flaps maintain a similar texture to the axillary region; but they are not indicated in wide excisions. Currently, a gold standard technique for axillary reconstruction after HS excision has not been recognized yet.<sup>3</sup>

The main aim of this work is to systematically review the literature of the past 40 years, to identify the best surgical technique for axillary reconstruction in terms of efficacy (lack of recurrence) and safety (lack of complications).

## Materials and Methods

We adhered to Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) throughout the whole review protocol build-up.<sup>8</sup> The review was not registered in any systematic review and meta-analysis registry. However, no study investigating axillary reconstruction in HS was identified in PROSPERO database.

Research question and PICO: What is the best surgical technique for reconstruction of the axilla after excision of the area affected by HS in terms of efficacy and safety among all those described in literature?

Population: Patients suffering from axillary hidradenitis, requiring immediate surgical reconstruction.

Intervention and comparison: Skin grafts, local random flap (defined as pure-skin flap with random vascularization), regional axial fasciocutaneous flaps, and regional perforator flaps.

Outcomes: Efficacy in terms of recurrence of hidradenitis, safety of the techniques expressed in terms of complications (recurrence, minor healing delay, infection, necrosis/failure). Failure was defined as a necrosis of the flap/graft requiring reoperation for achieving the coverage of the defect.

Literature research: MEDLINE, Embase, and Cochrane library were searched. We searched MeSH terms "axilla" OR "hidradenitis" AND "reconstruction" OR "flap" OR "graft."

Inclusion criteria: Patient with axillary HS Hurley stage II/III, clear description of patient characteristics and out-

comes, follow-up length clearly stated. Only English language studies were included.

Exclusion criteria: Patients with HS involving areas other than axillary region; studies describing patients affected by hidradenitis in which data about axillary reconstruction were not extractable, studies not clearly reporting the grade or a histological or clinical diagnosis of HS; HS Hurley stage I requiring simple excision without reconstruction, follow-up length not clearly stated.

Study selection and data extraction: analysis of the literature was performed by two coauthors independently and then matched. For every study, quality was assessed with National Institutes of Health (NIH) Quality Assessment Tool,<sup>9</sup> excluding from our research those with a score < 2. The score used for analytic studies was converted in a 1 to 9 scale, to be comparable with the case series scores. There were not disagreements among the interviewers regarding the quality of the studies included.

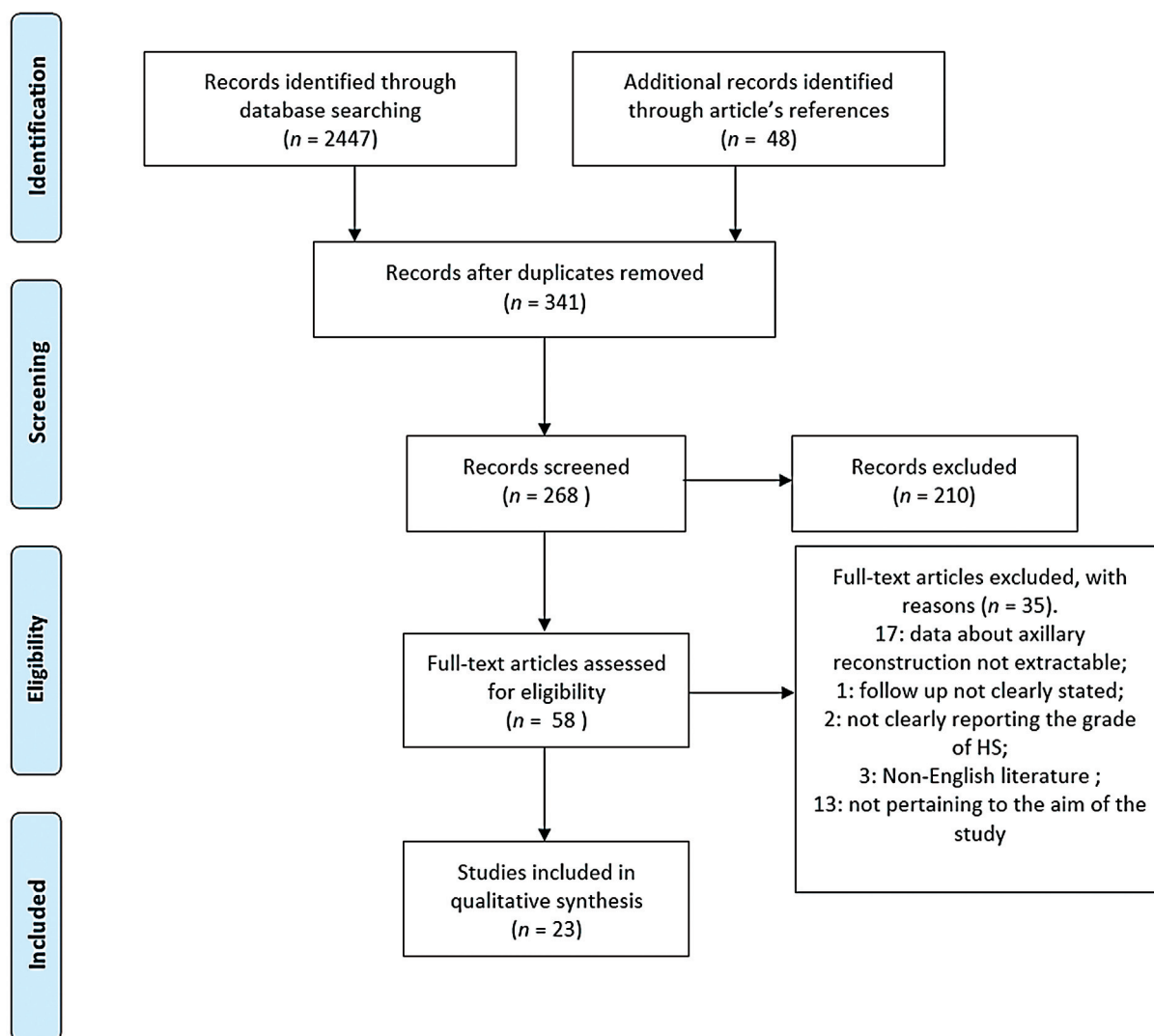
## Results

Overall, 2447 articles were retrieved from the preliminary search, updated to March 2021. The flowchart of the study selection process is outlined in ►Fig. 1. After removal of duplicates, 268 articles were screened by title and abstract. Only 57 articles were assessed for full-text eligibility, and among those, 22 studies were eventually included by criteria defined in the protocol (►Table 1).<sup>10–31</sup> Of the 35 articles excluded after full text screening, the majority was rejected due to follow-up length not clearly stated or patient characteristics not well described. Mean quality score was 6.4, ranging from 2 to 9, according to NIH Quality Assessment Tool.

A total of 394 axillary reconstructions, in 313 patients affected by AH at advanced stages, have been reviewed. All the papers included in the study deal with patients at Hurley stage III, except for Elgohary et al who included patients at Hurley stage II or III.<sup>11</sup> The median age was 32 years with a median duration of disease of 72 months before intervention. The median follow-up was 16 months. The median axillary area affected measured 85 cm<sup>2</sup>. The areas were reported in each study multiplying the height per the width of the defect after the primary excision (►Table 2). Only seven of the included studies described patients' anamnestic information such as tobacco use.<sup>10,12,13,20,23,30,31</sup> However, according to the available data, 57% of the patients reported to be active smokers.

Among the various surgical techniques, perforator flaps were used in 146 cases (37%), local random flaps in 105 cases (27%), regional axial flaps and skin grafts in 97 (24%) and 46 (12%) cases, respectively. Among perforator flaps the most used resulted to be the thoraco-dorsal artery perforator flap (TDAP) ( $n = 108$ ), while the most used regional axial flap was the posterior arm flap ( $n = 70$ ) followed by parascapular flap ( $n = 27$ ). Among the local random flaps, the Limberg flap ( $n = 98$ ) was the most described technique.

The overall complication rate was 71 (17%). Skin grafts were associated with the highest complication rate ( $n = 17$ , 37%), followed by local random flaps ( $n = 22$ , 19%) and



**Fig. 1** Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Flow Diagram. Adapted from Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097. For more information, visit [www.prisma-statement.org](http://www.prisma-statement.org).

perforator flaps ( $n = 20$ , 14%). The regional axial flaps demonstrated the lowest complication rate ( $n = 12$ , 11%).

Local random flaps demonstrated the highest rate of recurrence ( $n = 9$ , 8%). Perforator flaps, regional axial flaps, and skin grafts demonstrated comparable rates of recurrence ( $n = 3$ , 1, and 1, respectively).

Skin grafts resulted in the highest rate of minor healing delays ( $n = 7$ , 13%) and failure ( $n = 10$ , 22%). Low incidence of infection was reported for all the reconstructive techniques included in the study. Details about specific and global complication rates are shown in **Table 3**.

No clear differences were noted between perforator flaps and regional axial flaps, in terms of total complications, specific complications, and recurrences. However, both regional axial flaps and perforator flaps showed reduced failure rate compared with skin grafts (3% and 2 vs. 22%), but no remarkable differences in terms of recurrences, infections, or minor healing delays.

Among the most used singular techniques, the parascapular flap (7% of overall complications, none of recurrences and failures) proved to be associated with fewer complications than the TDAP (13% overall complications, 3% recurrences, 4% failure) and the posterior arm flap (15% overall complications, 1% recurrences, 2% failure).

## Discussion

HS is a chronic inflammatory disease of the follicular pilosebaceous unit.<sup>32</sup> It usually presents with painful nodules, which may be complicated by abscesses, leading to sinus tract formation, scarring, and fibrosis.<sup>16,32</sup> Surgical management demonstrated to significantly improve the quality of life in patients affected by advanced HS.<sup>33</sup> However, no actual gold standard reconstructive technique has been indicated after local excision of the HS affecting the axillary area.

**Table 1** Characteristics of the included studies

Authors (year)	Design	NIH assessment tool	Number of patients	Number of axillae	Treatment
Elboraey et al (2019) <sup>12</sup>	CS	8	6	8	Propeller flap on thoracodorsal or intercostal system
Sirvan et al (2019) <sup>30</sup>	CS	7	14	17	Posterior arm flap
Marchesi et al (2018) <sup>13</sup>	CS	8	12	17	15 TDAP, 2 MSLD
Elgohary et al (2018) <sup>11</sup>	Cohort	9	20	28	TDAP
Nail-Barthelemy et al (2018) <sup>10</sup>	CS	9	13	17	TDAP
Schmidt et al (2015) <sup>27</sup>	CS	6	20	31	Posterior arm flap
Ching et al (2017) <sup>28</sup>	CS	5	4	5	Inner arm perforator flap
Wormald et al (2014) <sup>26</sup>	Cohort	9	15	15	TDAP
			12	12	Skin graft
Alharbi et al (2014) <sup>29</sup>	CS	7	10	12	Inner arm perforator flap
Nesmith et al (2013) <sup>25</sup>	CS	4	11	15	Parascapular Flap
Hallock (2013) <sup>24</sup>	CS	5	2	3	VY thoracodorsal perforator Flap
Jandali et al (2012) <sup>22</sup>	CS	5	5	9	TDAP
Alharbi et al (2012) <sup>31</sup>	CS	7	16	16	Limberg random flap
			5	5	Parascapular flap
Gonzaga et al (2013) <sup>23</sup>	CS	6	4	8	Skin graft
Busnardo et al (2011) <sup>21</sup>	Cohort	8	12	24	TDAP
Varkarakis et al (2010) <sup>20</sup>	CS	4	15	21	Limberg random flap
Altmann et al (2004) <sup>19</sup>	CS	5	20	25	Limberg random flap
Geh and Niranjana (2002) <sup>18</sup>	CS	6	4	7	VY random flap
Schwabegger et al (2000) <sup>17</sup>	CS	2	7	8	LTAP
Soldin et al (2000) <sup>16</sup>	Cohort	8	16	16	Skin graft
			36	36	Limberg random flap
			7	7	Parascapular flap
Elliot et al (1992) <sup>14</sup>	CS	8	17	22	Posterior arm flap
Morgan et al (1983) <sup>15</sup>	Cohort	8	10	10	Skin graft

Abbreviations: CS, case series; LTAP, lateral-thoracic artery perforator; MSLD, muscle sparing latissimus dorsi; NIH, National Institutes of Health; TDAP, thoraco-dorsal artery perforator.

**Table 2** Patients' characteristics

	SG	LRF	RAF	PF
Number of treated axillae	46	113	107	143
Mean patient's age (years)	32,4	34,9	37,6	35
Defect width range (cm <sup>2</sup> )	88 <sup>15</sup> –437,5 <sup>24</sup>	85 <sup>25</sup>	39,5 <sup>31</sup> –487,9 <sup>26</sup>	58 <sup>10</sup> –160,4 <sup>122</sup>
From diagnosis to surgery range (months)	36 <sup>24</sup> –42 <sup>17</sup>	42 <sup>17</sup> –84 <sup>19</sup>	42 <sup>17</sup> –112,8 <sup>14</sup>	123,6 <sup>30</sup>
Mean follow-up (months)	21	12,1	26	17

Abbreviations: LRF, local random flap; PF, perforator flap; RAF, regional axial flap; SG, skin graft.

Following our systematic review of the literature, a total of 409 axillae were reconstructed with different techniques, ranging from skin graft to perforator flaps. We identified several small case series and few comparative cohort studies, with no large high-quality datasets.

Different surgical techniques demonstrated to be effective. Local random flaps showed the highest rate of disease recurrence, confirming the limited role for minor surgical excision in the treatment of axillary HS. Therefore, wide local excision of the entire hair bearing

**Table 3** Results of each type of reconstruction

	SG	LRF	RAF	PF	Total
Number of treated axillae	46	105	97	146	394
Total complications	17 (37%)	22 (19.5%)	12 (11%)	20 (14%)	71 (17.4%)
Recurrence	1 (2.2%)	9 (8%)	1 (1%)	3 (2%)	14 (3.4%)
Minor healing delay	6 (13%)	7 (6.2%)	9 (8.4%)	12 (8%)	34 (8.3%)
Infection	0	0	1 (1%)	2 (1.4%)	3 (0.7%)
Failure	10 (22%)	6 (5.3%)	2 (1.9%)	5 (3.5%)	23 (5.6%)

Abbreviations: LRF, local random flap; PF, perforator flap; RAF, regional axial flap; SG, skin graft.

area should be considered as the most effective surgical approach.<sup>16,34</sup>

Skin grafts were associated with the highest overall complication rate, with high rate of failure of the reconstruction. Perforator and regional axial flaps were characterized by the lowest complication rates, thus being the safest techniques for axillary reconstruction.

Perforator flaps were the most used reconstructive technique for advanced axillary HS. Among perforator flaps, the TDAP flap was the most frequently performed and it demonstrated acceptable complication and recurrence rates.<sup>11</sup> The TDAP flap includes the advantages of a similar texture, color, and thinness to the axillary area. It also allows the maintenance of the axilla's diamond shape, with low rate of bumps and distortions.<sup>11,21</sup> Furthermore, it can be used for extensive resection without long-term retractions.<sup>11,21</sup> However, Elgohary et al described a 10.71% prevalence of scar widening and 10% of donor site morbidity (hypertrophic scar or seroma).<sup>11</sup> The TDAP flap also requires a meticulous preoperative planning, with the mapping of the perforators, and a consistent operative time.<sup>11,13,26</sup> Wormald et al compared the use of TDAP with the skin graft for axillary reconstruction in patients affected by HS, and showed a significantly improved quality of life in the TDAP group.<sup>26</sup> Similarly, Busnardo et al demonstrated a significant increase in arm abduction and mobility of the arm and shoulder at 6 months follow-up using the TDAP flap after excision of severe axillary HS.<sup>21</sup>

Regional axial flaps demonstrated the lowest overall complication rate in our study. Among the 107 regional axial flaps used for axillary reconstruction, the posterior arm flap was the most common, with a 15% of overall complication, 1% of recurrences, and 2% of failures. The pedicle of the flap is defined as the cutaneous branch of the artery supplying the medial head of the triceps muscle, which arises from either the brachial or deep brachial artery.<sup>27,30,35</sup> This flap is considered to be safe and feasible for some authors, which observed a constant anatomy and a vigorous blood supply.<sup>27,30</sup> Although donor site morbidity is considered low and comparable to a posterior brachioplasty, the donor site scar is usually visible when wearing short-sleeved T-shirts, differently from other reconstructive techniques, and be troublesome for some patients.<sup>27</sup> Moreover the posterior arm flap tends to be bulky in the axillary reconstruction due to the fact that the arm tissue is

relatively thicker than the axillary tissue.<sup>14,30</sup> The TDAP flap showed similar outcomes of posterior arm flap, but with more recurrences and failures.

The parascapular flap was the second most used regional axial flap, and demonstrated better outcomes compared with the posterior arm flap, with similar rate of complications and no recurrences or failures registered.

Local random flaps were the second most used technique, but they resulted to be significantly associated with disease recurrences than the other techniques included in our study, mainly due to the associated smaller excisions. Varkarakis et al reported satisfying reconstructions using the Limberg local plasty. However, 9.5% of patients had a delayed restoration of shoulder motion requiring physical therapy.<sup>20</sup>

Skin grafts were associated with the highest complication rate, reporting numerous failures and minor healing delays. Several authors discourage the use of skin graft for axillary reconstruction. Other than poor graft takes long recovery, skin grafts are often cosmetically unsatisfactory and often develop retractions leading to joint contractures, thus impairing the upper limb motion.<sup>16,26,29</sup>

The extension of the defect guides the reconstructive option. In fact, HS affects only the hair bearing area of the axilla, not extending beyond the posterior axillary fold. Therefore, a regional flap from the scapular region is almost always feasible. Even if the reconstructive ladder imposes the use of local random flaps as the first choice for small defect, in this context small excisions were shown to be burdened by a higher risk of relapse. Thus, a wide excision of the entire axillary hair-bearing region is advisable to reduce recurrences. According to our analysis, regional axial flaps should be considered as the first choice in axillary reconstruction after HS demolition at advanced stages, because they demonstrated to be effective in preventing postexcision disease recurrence and to be associated with the lowest complication rate. The parascapular flap emerged as the most effective and safest option for axillary reconstruction. The second option should be the posterior arm flap, safer and cosmetically more acceptable than the TDAP flap. Based on the findings of our study, we discourage the use of skin grafts for axillary reconstruction.

The main limits of our work include the overall low quality of evidence of the studies included in the review due to absence of randomized controlled trials. The majority of patients' data were obtained from case reports and small

case series and therefore a formal meta-analysis could not be performed. Further weakness of the available dataset is the lack of information about patients' comorbidities, with only seven of the included studies reporting anamnestic information of the treated patients, as well as the lack of evidence in patient-reported quality of life after every single reconstructive technique. We are also conscious of the possible unreliable assessment of the Hurley stage by the different groups.

## Conclusion

Based on the available literature on axillary HS, perforator and regional axial flaps show better outcomes and low rates of complications. However, regional axial flaps have the most consistent safety and efficacy profile. Among regional axial flaps, the parascapular flap appears to be the most reliable and safe procedure.

Due to the low quality of the studies available in literature and the lack of patients reported outcomes, further investigations are warranted before a determined surgical approach could be considered as the gold standard treatment option.

### Conflict of Interest

None declared.

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