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Systematic Review

Surgical Methods of Management for Hidradenitis Suppurativa: A Narrative Review

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ABSTRACT

Objective
Hidradenitis Suppuravita (HS) is a chronic condition that creates a significant burden on a patient's life, both physical and emotional. While a broad range of medical and dressing treatments exist for HS, surgery is often considered the only curative approach. The aim of this study is to comprehensively review existing and emerging surgical options available for the treatment of HS.

Methods
Using the key phrase "Hidradenitis Suppuravita" and the MeSH terms "surgery or surgical" and "treatment or procedure", a search of the Ovid Medline and Pubmed databases was conducted 2012 to 2022. Forty-eight studies meeting criteria were identified and included in the literature review.

Results
Many methods exist for the treatment of HS and there have been promising small scale series and reports that highlight positive disease and quality-of-life (QoL) outcomes associated with some surgical treatment modalities. Most methods are centred around excision of all diseased tissue followed by varying methods of reconstruction. Some novel methods, such as laser ablation, are also used. Each method has its own strengths and weaknesses. Selection of method is currently made based on a case-by-case basis such as disease severity, disease location and surgeon preference.

Conclusion
Further randomised control trials with larger patient populations are needed to quantify the efficacy and safety of the various surgical methods available. These approaches to treatment hold tremendous potential for improving patient outcomes globally.

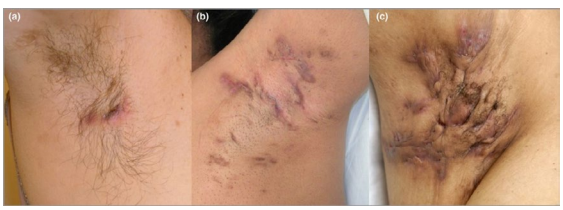
Keywords
Hidradenitis suppurativa; Acne inversa; Surgery; Surgical; Treatment; Procedure.

INTRODUCTION

Hidradenitis Suppurativa (HS), also known as acne inversa, is a chronic inflammatory condition that affects millions worldwide.[1,2] HS is characterised by the development of painful nodules, abscesses and sinus tracts which can become infected and purulent.

Excruciating pain, reduction in range of motion (ROM) and issues with mental health and self-esteem are reported as significant, and detrimental to patient quality-of-life (QoL).[3] The severity of HS is most often measured using the Hurley staging system, ranging from I-III. Stage I is characterised by the presence of abscesses without any sinus tracts or scarring. Stage II involves multiple abscesses or sinus tracts existing in a single area. In stage III, sinus tracts and scarring are interconnected, and multiple absc-

Figure 1. *Photos of HS Lesions*



(a) Hurley stage I HS with one or possibly two solitary nodules. (b) Hurley stage II HS with multiple abscesses. (c) Hurley stage III HS with diffuse and connected abscesses, sinus tracts and cicatrization.[1]

esses occur in the region.[1] Figure 1 describes the different stages of the Hurley staging system.

For mild HS, management is typically conservative in nature, involving topical antiseptic wash or topical antibiotics such as 0.1% clindamycin.[4] Other options for mild to moderate HS are the use of long course oral antibiotics, or in severe cases, treatment with biological agents such as tumour necrosis factor (TNF) inhibitors adalimumab or infliximab.[5]

Surgery is indicated when HS is not medically responsive and is considered the only definitive treatment for recurrent abscesses and sinus tracts associated with stage II-III HS.[6] Currently there are a wide range of approaches available, however, there is no consensus on the timing and type of surgery that should be performed. As such, this review aims to critically evaluate the surgical methods of treating HS and their outcomes, as reported in the literature.

METHODS

The Ovid Medline and PubMed databases were used to search for relevant literature. Manuscripts with type I-V[7] evidence were included. The search phrases used for both databases were as follows:

- (Acne inversa OR hidradenitis suppurativa) AND (surgery OR surgical) AND (management OR treatment) with the following filters applied: Last 10-years, Full text available in English.

Inclusion Criteria

1. The full text was available in English.
2. The literature was published in the last 10 years (2012- current).
3. The article was relevant to the surgical treatment of hidradenitis suppurativa with a surgical treatment defined as "*the use of instrumentation or manual methods to make an incision or remove body tissues in the treatment of a pathological process*".
4. The primary outcome of "*recurrence of HS after surgery*" was reported.

Secondary outcomes assessed in included articles were: surgical complications, restriction in ROM post-surgery and QoL changes post-surgery.

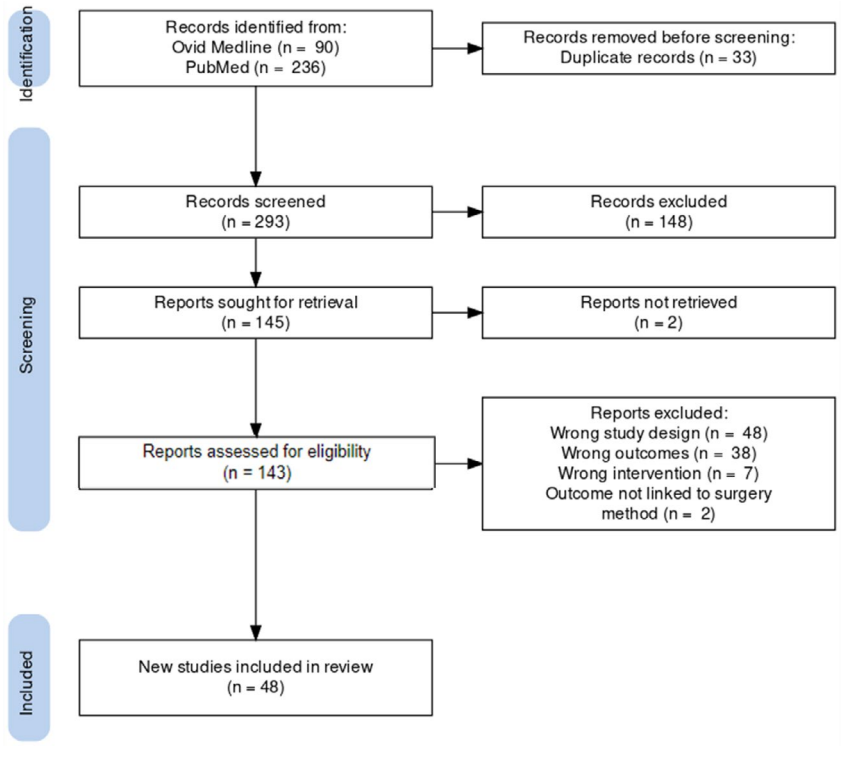
Exclusion Criteria

- The article did not report whether recurrence occurred post-surgery.
- The recurrence rate was not linked to a defined surgery method.
- The article was a review.

RESULTS

The search yielded 326 results, 33 duplicates were removed, and 293 articles underwent title and abstract screening. The title and the abstract were assessed using the inclusion and exclusion criteria and 145 articles were sought for a full text review. Two articles could not be retrieved in English and thus only 143 articles were analysed in the full text review. During the full text review articles were read in full and assessed against the exclusion and inclusion criteria. At the end of this process 48 articles were included in the review. Figure 2 summarises the search.

Figure 2. *PRISMA Flow Diagram of the Screening Process Used in this Review*



Incision and Drainage/Deroofing Procedures

Incision and drainage (I&D) is typically used in more acute disease lesions either when only abscesses or nodules exist, such as Hurley Stage I disease. After thorough washout of the cavity, the wound is packed with dressings and allowed to heal secondarily.

Deroofing is a procedure in which a superficial portion of a nodule or sinus tract is excised, leaving the floor of the tract or nodule to allow for more rapid re-epithelisation with the wound left to heal by secondary intention. A skin tissue sparing excision and electrosurgical peeling (STEEP) technique is a type of deroofing whereby a HS lesion is removed in a layer-by-layer fashion until the floor of the tracts is left. Table 1 outlines the articles that performed I&D and deroofing procedures included in this review.

Surgical Excision

Surgical excision, either wide or radical, was the most reported surgical treatment. It was typically offered for Hurley Stage II or III disease. The wound was either allowed to heal by secondary intention (SIH), primarily closed, or reconstructed with a skin graft or flap. Wide excision typically detailed excision down to healthy tissue whereas radical excision typically referred to excision down to mus-

Table 1. *Summary of Articles that Examined I&D or Deroofing Procedures*

Author	Disease Location	Procedure Type	Number of Procedures Performed	Recurrence Rate (mean follow-up time)	Secondary Outcomes Reported
Haoxiang et al[8]	Axilla	Incision and drainage with hydrogen peroxide wash	8	19% (3-months)	87.5% of patients had postoperative complications
Janse et al[9]	Axilla	STEEP procedure	16	50% (8.26-months)	62.4% of patients had hyper granulation
Lin et al[10]	Axilla Gluteal	Deroofing and healing by second intention	1	None at 3-months	-
Molina-Leyva et al[11]	Gluteal	I&D with punch-trocar-assisted cryoinsufflation	10	30% (6-months)	-
Ravi et al[12]	Axilla, Gluteal Inguinal	Deroofing, secondary intention healing	129	33% (1-year)	--

Table 2. *Summary of Articles Examining PC or SIH Wound Method Post-surgery*

Author	Disease Location	Procedure type(s)/ Reconstruction Method(s) Examined	Number of Procedures Performed	Recurrence Rate (mean follow up time)	Secondary Outcomes Reported/Key Findings
Chen et al[13]	Axilla Groin	Wide excision, immediate PC (n=15) or delayed vacuum assisted PC (n=12)	27	At 3-months Immediate closure: 13% (n=2) Delayed closure: 0%	Immediate closure group had no complications, delayed closure group complication rate was 75%
Deckers et al[14]	Axillary Groin Gluteal/anal	Moderate to severe Galbellar rhytides Wide excision, secondary intention healing	86	At 36-months 51%	Genital region most prone to recurrence
DeFazio et al[15]	Axilla	Wide excision, delayed primary closure +/- biological therapy	Surgery only n=26 Combined therapy n=29	At 10.5-months Surgery only=38.5% Combined therapy=19%	-
Fertitta et al[16]	Axilla, Groin, Gluteal, Inguinal Head and neck	Limited local excision or wide excision, SIH	58	At 15-months Limited excision: 25% Wide excision: 14%	10% complication rate overall
Ezanno et al[17]	Axilla	Radical excision, SIH after negative pressure therapy	36	At 16-months 2%	13.9% complication rate (pain, infection and loss of mobility)
Kofler et al[18]	Axilla, Groin, Gluteal, Inguinal, Chest	Wide excision, secondary intention healing	255	At 57-months 69%	25% of patients experienced at least one surgical complication
Mendes et al[19]	Axilla, Gluteal	Radical excision, PC	2	At 1-year 100%	Complication rate of 85% (mainly wound dehiscence)
Ngaage et al[20]	Axilla, Gluteal, Groin	Wide excision, PC	72	At 33-months 30%	30% complication rate
Ovadja et al[21]	Axilla	Wide excision, PC, or SIH	PC n=56 SIH n=23	At 43-months PC=62.5% SIH=70%	-
Posch et al[22]	Axilla, Gluteal, inguinal	Wide excision, SIH	74	At 1-year 18.9%	47% long term complication rate (mostly pain and scarring)
Ravi et al[12]	Axilla Gluteal Inguinal	Wide excision, PC or SIH	PC n=53 SIH n=12	At 1-year PC=51% SIH=75%	-
Shavit et al[23]	Axilla	Wide excision, SIH	35	At 14.5-months 18%	-

cle fascia. Table 2 summarises the studies that used primary closure or healing by secondary intention following excision of HS.

Skin Grafting/Flap Reconstruction

Split thickness skin grafts (STSG) were used as a single stage reconstruction or two stage reconstruction with an adjunct such as negative pressure wound therapy (NPWT) or dermal matrices used as bridging treatments prior to definitive skin grafting.[24] Table 3 summaries the articles that examined skin grafts as a wound closure method post-surgery.

Multiple tissue flaps have been described to reconstruct various defects. The flaps used were all variations of perforator flaps with different characteristics such as donor site and advancement method. In perforator flap reconstruction, perforator vessels are left intact as the flap is moved to its new location creating a "pedicle" that connects the donor site with reconstruction site that the flap has been moved to. This type of reconstruction is beneficial in HS cases as it allows for areas with wide defects to be reconstructed. Table 4 summarises the articles reporting flap use as part of the surgical management of HS.

Novel Techniques

Three novel techniques were identified in the literature search. These techniques involved removing diseased tissue using CO_2 lasers using a layer-by-layer approach like the STEEP procedure. Table 5 summaries the articles using novel techniques.

DISCUSSION

There was no standardised treatment protocol for HS. Less invasive methods such as incision and drainage were offered for early

Table 3. *Summary of Articles Using Skin Grafts*

Author	Disease Location	Procedure type(s)/ Reconstruction Method(s) Examined	Number of Procedures Performed	Recurrence Rate (mean follow up time)	Secondary Outcomes Reported/Key Findings
Ayala et al[25]	Axilla Groin Inguinal	Wide excision, split thickness skin graft (STSG) or primary closure	139	STSG: 25% Primary closure: 40%	Axillary HS treatment has the highest success rate and lower infection/complication rate than HS in other areas
Chaffin et al[26]	Axilla	Wide excision, delayed STSG with ovine forestomach ECM	6	None at 7-months	Minor wound dehiscence in 1 patient
Chen et al[27]	Genitoperineal	Radial excision, STSG (n=4) or local skin flap (n=2)	6	STSG: 25% (n=1) Local skin flap: 0%	-
El-Helou et al[28]	Perineal	Radical excision, delayed STSG with Vacuum negative pressure therapy and ECM	1	None at 1-year	-
Ge et al[29]	Axilla, Gluteal, Groin, Chest Perineal	Wide excision, delayed STSG with negative pressure wound therapy	12	None at 4-years	-
Gonzaga et al[30]	Axilla	Wide excision, delayed STSG with Vacuum negative pressure therapy and ECM	4	None at 23-months	-
Hsiao et al[31]	Axilla	Wide excision, full thickness skin graft from excised tissue (defatted and lesions removed)	1	None at 8-months	No ROM impairment
Kraft et al[24]	Axilla	Wide excision, STSG with NPWT and Dermal regeneration template	7	None at 9-months	- No shoulder ROM impairment - No Complications
Lim et al[32]	Gluteal	Wide excision, delayed STSG with negative pressure therapy	1	None at 1-year	-
Maeda et al[33]	Gluteal	Wide excision, STSG from recycled excised tissue or donor site if needed	18	None at 36-months	-
Mendes et al[19]	Axilla Gluteal	Radical excision, STSG	2	At 1-year 50%	Complication rate of 50% (mainly wound dehiscence)
Ngaage et al[20]	Axilla, Gluteal, Groin	Wide excision, STSG	35	At 33-months 23%	29% complication rate
Ovadja et al[21]	Axilla	Wide excision, STSG	11	At 43-months 63%	-
Steele et al[34]	Axilla, Inguinal	Wide excision, STSG	4	At 1-year 25%	-
Wormald et al[35]	Axilla	Wide excision, STSG	12	None at 23-months	25% of patients had ROM restriction
Yamashita et al[36]	Axilla Gluteal	Wide excision, delayed STSG with ECM and negative pressure therapy	32	At 12.3-months 3%	50% surgical complication rate (wound dehiscence and infection)

Table 4. *Summary of Articles Using Flaps*

Author	Disease Location	Procedure type(s)/ Reconstruction Method(s) Examined	Number of Procedures Performed	Recurrence Rate (mean follow up time)	Secondary Outcomes Reported/Key Findings
Alharbi et al[37]	Axilla	Wide excision in axilla, VY inner arm flap	10	None at 13-months	- 30% of patients experienced delayed healing - Donor site scars were noticeable, - High axilla ROM
Elboraey et al[38]	Axilla	Radical excision, perforator propellor flap from costal region in midaxillary line	8	None at 10-months	- 36% complication rate wound dehiscence (n=2), venous congestion (n=1)
Elgohary et al[39]	Axilla	Wide excision, pedicled thoracodorsal perforator flap	28	None at 30-months	- 10% complication rate (bleeding: n=1, wound infection: n=2) - Significant shoulder ROM reported
Fu et al[40]	Head and neck	Wide excision, perforator forehead flap	1	None at 7-months	-
Hallock[41]	Axilla	Radical excision, VY advancement of thoracodorsal perforator flap	3	None at 9-months	Full range of motion regained post-surgery
Hoang et al[42]	Groin	Wide excision, superficial inferior epigastric artery flap from abdominal pannus	1	None at 12-months	-
Marchesi et al[43]	Axilla	Wide excision, thoracodorsal perforator flap or latissimus dorsi muscle sparing flap	15	None at 16-months	Early complication rate of 29% (mainly wound dehiscence) and late complication rate of 35% (mostly need for flap debulking)
Marchesi et al[44]	Axilla Gluteal Inguinal	Wide excision, PC	26	None at 1-year	- Large quality of life increase (DQLI Δ=-16) - Complication rate of 42% (mainly wound dehiscence)
Mendes et al[19]	Axilla, Gluteal	Wide excision, PC, or SIH	25	At 1-year 53%	Complication rate of 60% (mainly wound dehiscence)
Mutaf et al[45]	Gluteal Sacrococcygeal	Wide excision, SIH	16	None at 36-months	-
Nail-Barthelemy et al[46]	Axilla	Wide excision, PC or SIH	13	None at 9-months	Maximum angle of shoulder abduction post-surgery=160°
Nesmith et al[47]	Axilla	Wide excision, SIH	11	None at 4.3-years	-
Ngaage et al[20]	Axilla Gluteal Groin	Wide excision, delayed primary closure +/- biological therapy	96	At 33-months 21%	34% complication rate
Oliveria et al[48]	Intermammary	Limited local excision or wide excision, SIH	1	At 9-months Recurrence in patient	Distal flap tip necrosis occurred
Ovadja et al[49]	Axilla	Radical excision, SIH after negative pressure therapy	3	None at 43-months	-
Rodriguez et al[50]	Axilla	Wide excision, secondary intention healing	2	None at 2-months	-
Shavit et al[23]	Axilla	Radical excision, PC	100	At 14.5-months 18%	-
Steele et al[34]	Axilla Inguinal	Wide excision, PC	1	None at 1-year	-
Teo et al[51]	Axilla	Wide excision, PC, or SIH	2	None at 11-months	Full shoulder ROM regained
Thomson et al[52]	Axilla	Wide excision, SIH	8	None at 15-months	25% surgical complication rate (wound dehiscence and haematoma)
Virág et al[53]	Axilla Inguinal Sacrococcygeal	Wide excision, PC or SIH	22	None at 6-months	-
Wormald et al[35]	Axilla	Wide excision, SIH	15	At 23-months 7%	Full ROM regained

Table 5. *Summary of Articles Examining Novel Techniques*

Author	Disease Location	Procedure type(s)/ Reconstruction Method(s) Examined	Number of Procedures Performed	Recurrence Rate (mean follow-up time)	Secondary Outcomes Reported
Abdel Azim et al[54]	Axilla	Ablation using CO_2 laser in conjunction with Nd:YAG laser radiation	20	At 3-months CO2 and NdYAG laser: 45% Nd:YAG laser only: 80%	-
Hazen et al[55]	Groin	Excision and marsupialisation using CO_2 laser	1	None at 18-months	-
Mikkelsen et al[56]	Axilla	CO_2 laser evaporation, secondary intention healing	58	At 20.6-months 29%	-

HS (Hurley stage I) and were sometimes paired with the use of hydrogen peroxide or cryoinsufflation with liquid nitrogen. These methods aimed to optimise healing by removing the bacterial load in the area. These treatments were effective in reducing pain and discomfort associated with HS lesions. However, they were also associated with a moderate rate of recurrence (19-30%). It should be noted that there was a small number of articles that reported I&D procedures and as such the recurrence rates are most likely not indicative of all I&D patients.

Deroofing procedures reported recurrence rates of 0 to 30% with the most common complication being post-surgical hyper-granulation.[9,10] Recurrence in these procedures is thought to be related to unexcised diseased follicles that were either deep to the margins of the deroofing or from sinuses that were not completely deroofed[9] or from previously normal follicles that have progressed to become diseased after the procedure. The success of deroofing procedures is heavily determined by the ability of the surgeon to identify and deroof all lesions in the area or patient factors such as the severity of HS or complexity of sinus networks. Deroofing appears to be a viable option for patients not suited to or not willing to undergo larger procedures, however, there have not been any large cohort studies examining efficacy, nor have there been any trials comparing it to other surgical methods.

Surgical Excision

Management after excision was varied. Primary closure and healing by second intention were associated with shorter operating time and required less follow-up monitoring, but were associated with high rates of recurrence, with rates between 18% and 75% in larger cohort studies (n>30). The reported complication rates varied significantly between the articles that examined methods using excision and repair with primary closure or healing by second intention. However, the most frequently reported complications were wound infections and post-operative pain.[12,16,18-22,24] Some proposed reasons for this were that secondary intention healing and primary closure were typically suited to smaller wounds. Limited excision is likely to leave some diseased follicles behind and thus leave a seed for recurrence. However, this has not been proven.

Most of the patients who underwent secondary intention healing or primary closure had HS of Hurley stage I-II and this may be because primary closure (PC) and SIH may not be possible for wide and deep wounds. More severe Hurley stage II or Hurley stage III HS typically encompass wider areas and have tracts extending deeper into the dermis or adipose tissue of the area and the large wounds left from complete excision of diseased tissue would be difficult to close using PC and may lead to significant restrictions in ROM. Wide excision with SIH or primary closure is most suited to less severe HS or smaller disease areas in regions that are easier to access or where ROM impairment is not as big of a factor.

Skin Grafts

Skin grafts were a commonly reported method of wound closure after wide or radical excision of HS. There were two main methods of skin grafting, immediate or delayed. In some delayed grafting methods, adjunct treatments such as vacuum dressing assisted NPWT, or dermal matrices, were used to aid granulation tissue formation and vascularisation of said tissue before grafting. The aim of this was to improve ROM and aesthetic outcomes by reducing scar contracture. These adjuncts were commonly used in axillary cases of HS where ROM impairment significantly impairs QoL.[24,26,36]

Most articles examined reported no recurrence of HS post excision and skin graft, however Ovadja et al[21] and Mendes et al[19] reported recurrence rates of 63% and 50% with samples sizes of 11 and 2 respectively. Similarly to deroofing procedures, it is postured that local recurrence stems from incomplete removal of diseased follicles or from progression of healthy follicles to a diseased state. The most common complication was wound dehiscence, but the rates were highly varied between papers. Overall, skin grafting, especially when used after surgical excision was reported to be an effective treatment for HS with low recurrence and good outcomes functionally (low ROM restriction) and aesthetically, while being appropriate for HS of large areas. Thus, suggesting that these methods could be applied to HS of high severity in most areas of the body. It is noted however that delayed skin grafting with adjuvants requires a high-level of patient adherence, as these methods involve regular wound dressing management or temporary movement restricting braces such as 90-degree abduction shoulder braces to optimise the NWPT or extracellular matrix (ECM) adjuncts. As such, optimal treatment results require discussion on these points to be held before treatment is commenced.

Flap Reconstruction

The aim of using flaps was to allow for large areas of radical exci-

sion to excise as much diseased tissue as possible, while having a method of reconstruction that would be able to close the site and allow for good functional outcomes. Flaps help achieve this goal as having their own blood supply, flaps can be used to cover large areas while also being unlikely to exhibit any contraction and thus are unlikely to impair ROM in the long-term.[57]

The use of flaps does pose some challenges. Procedures involving flaps take significantly longer than other options such as skin grafting and are often more complicated with considerations for the flap donor site, flap blood supply, flap advancement and long-term flap monitoring, needing to be made. Within this study, flaps were typically reported to be used for cases of axillary HS or gluteal/groin HS where the lesion area was large. The flaps used were local or perforator flaps with no free flaps being reported. Recurrence rates were generally low with the majority of articles reporting rates between 0% and 7%, however, a small number of articles reported higher recurrence rates of 18%-53% with moderate patient sample sizes (n=25 to n=100). Complication rates varied with reports ranging from no complications to 42% complication rates post-surgery. Of the reported complications, wound dehiscence and minor flap necrosis were the most reported and highlight the complexities of constructing flaps with adequate blood supply and underlining the need for long-term surveillance of the flap. Positive functional outcomes were widely reported especially in axillary cases of HS. Shoulder ROM was reported to range between 160° of abduction and full ROM post-surgery and the reporting of contracture was rare, occurring along scar lines along the flap's border in some cases but did not significantly hinder ROM. Overall flap reconstruction was effective at preserving ROM and covering areas of wide excision like those found in the treatment of severe HS. Of note however, is the increase in complexity in surgery and treatment follow-up when using flaps.

Novel Techniques

The novel techniques identified revolved around laser ablation or removal of diseased tissue. Hazen et al[55] and Mikkelsen et al[56] examined the use of CO_2 laser to ablate diseased tissue while Abdel Azim et al[54] examined CO_2 laser ablation and Nd:YAG laser treatments. Nd:YAG lasers work by emitting a wavelength or radiation that is highly absorbed by hair follicles and thus theoretically destroys or partially cauterises the follicle. Recurrence rate varied, ranging from 0 to 45% with CO_2 laser treatment, while Nd:YAG monotherapy was reported to have a 80% recurrence rate. A positive characteristic of laser ablation is that the ablation of tissue also provides a haemostatic effect like electrocautery which could be beneficial during treatment of wide areas or areas with a higher bleeding risk.

LIMITATIONS

There were several factors that prevented quantitative comparison between articles reporting different surgical treatment methods. Reporting of outcomes was incredibly varied. There was no standard follow-up time, no standard set of reported outcomes and recurrence rate was often variable even when comparing articles examining similar procedures. Ununiform reporting was further compounded by the heterogenous nature of HS with differing disease morphology and patient co-morbidities making each case slightly different and not directly comparable to other patients. The inclusion of all articles with evidence levels of type I-V meant that novel and small sample size procedures could be assessed and discussed but also meant that quantitative comparisons would not be reliable. Comparisons between QoL improvement could not be made as this was not widely reported and a common scale for assessing this was not adopted between studies.

CONCLUSION

Surgical management is an effective treatment for HS. It has the potential to be curative even in severe cases of HS. Factors such as surgeon preference, disease severity and patient goals influence what treatment is offered. Despite this, most methods share the same principle of excision of as much diseased tissue as possible. For Hurley Stage I lesions, incision and drainage is the less invasive option that is effective in managing symptoms such as pain. For Hurley Stage II-III lesions, wide excision with reconstruction seems to be a curative option that preserves function of the affected area. However, there are currently no randomised control trials comparing different methods and this is likely due to the heterogenicity of disease morphology and lack of defined treatment algorithm.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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