Journal of Carcinogenesis
Covering Genesis to Therapeutics

Journal of Carcinogenesis, ISSN: 1477-3163
2025; Vol 24: Issue 8s, https://carcinogenesis.com/

Modified Limberg Flap versus Modified Elliptical Rotational Flap for Recurrent Pilonidal Sinus Disease

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ABSTRACT

Background: Over the past few decades in the management of sacrococcygeal pilonidal sinus disease, surgeons have increasingly come to appreciate the importance not only of flattening the natal cleft but also of achieving an off-midline closure of the resultant defect in order to minimize wound-related complications and recurrence.

Purpose: This study aims to compare modified Limberg flap (MLF) and modified elliptical rotational flap (MERF) for recurrent pilonidal sinus

Material and Methods: This cross-sectional study was carried out in the Department of General Surgery at October 6 University Hospital between January 2023 and January 2025, and included 50 patients with recurrent pilonidal sinus disease. Patients were randomly divided into two groups: Group A (25 patients treated with a modified Limberg flap, MLF) and Group B (25 patients treated with a modified elliptical rotational flap, MERF). Inclusion criteria were both genders with recurrent disease within two years and no more than one recurrence, while exclusion criteria included primary disease, contraindications to surgery, or prior flap surgery. Standard preoperative assessment and prophylactic antibiotics were applied, and all surgeries were performed by senior surgeons using standardized techniques with closed suction drainage. Postoperative outcomes, including operative time, healing, complications, recurrence, return to work, and patient satisfaction, were recorded during a 24-month follow-up.

Results: Fifty patients with recurrent pilonidal sinus were studied, most of whom were male (84%) and had previously undergone open surgery (60%). Compared with the modified Limberg flap (MLF), the modified elliptical rotational flap (MERF) required longer operative time but showed faster healing, earlier return to work, and significantly higher patient satisfaction and cosmetic scores. Recurrence was lower in the MERF group (4% vs. 12%), though not statistically significant. Postoperative complications, including numbness, tightness, infection, seroma, and wound dehiscence, were comparable between groups with no significant differences.

Conclusion: MLF remains a reliable technique with shorter operative time, MERF demonstrated superior outcomes in terms of healing, return to work, cosmetic satisfaction, and possibly recurrence. The longer operative time of MERF is offset by its functional and aesthetic benefits, making it a favorable choice in recurrent PSD where tissue planes are distorted and recurrence risk is high. Both techniques were safe, with comparable rates of complications. The differences observed between our study and previous literature emphasize the complexity of recurrent PSD, where operative challenges, patient compliance, and postoperative care critically influence outcomes.

Keywords: *Modified limberg flap reconstruction; modified the limberg flapreconstruction; Pilonidal disease.*

How to Cite: Ahmed Z. Ghareeb, Adel M. Abdallah, Abdelaal M, Ayman M. Ghaly, Mona Fathy A. Abdou, (2025) Modified Limberg Flap versus Modified Elliptical Rotational Flap for Recurrent Pilonidal Sinus Disease, *Journal of Carcinogenesis*, *Vol.24, No.8s*, 734-744

1. INTRODUCTION

Sacrococcygeal pilonidal sinus is a chronic disease that mostly affects young adults. Pilonidal disease can be considered an acquired disease, even though etiopathogenesis is still not well defined [1].

Pilonidal sinus is an acquired condition with high postoperative morbidity and patient discomfort. The most important predisposing factors for the development of pilonidal sinus are the existence of a deep natal cleft and the presence of hair within the cleft. A deep natal cleft is a favorable environment for sweating, maceration, bacterial contamination and penetration of hairs [2].

Surgery is the main treatment, and up to 40% of patients develop recurrence. The management of patients with recurrent disease has led to the development of different surgical approaches. The surgical treatments of primary pilonidal sinus include a wide spectrum of techniques that vary from sinus excision with secondary healing of the surgical wound or marsupialization, to the use of flap reconstruction [3]. Primary closure is preferred in patients with pathology limited to the midline and for whom residual defect after excision is narrow: Karydakis or Bascom procedure can be used. When the residual defect is anticipated to be wide, excision with secondary healing of the wound or flap reconstructions are preferred. The management of the patient with recurrent disease may require a more complex surgical approach as the excision may be wider or the initial surgery may have led to the loss of the intergluteal tissue. Flap reconstruction techniques eradicate the etiology of the disease by flattening the intergluteal sulcus with much less hairy fasciocutaneous flaps and less perspiration [4]. Mentes et al. modified the Limberg flap reconstruction by tailoring the rhomboid excision asymmetrically to place the lower pole of the flap 1–2 cm lateral to the inferior midline [5]. Nessar et al. first described the elliptical rotation flap reconstruction for pilonidal sinus disease to facilitate an off-midline closure and to achieve a better natal cleft flattening [6].

This study aims to compare modified Limberg flap (MLF) and modified elliptical rotational flap (MERF) for recurrent pilonidal sinus

2. MATERIAL AND METHODS

This cross-sectional study was conducted at the Department of General Surgery, Faculty of Medicine, October 6 University Hospital, between January 2023 and January 2025. It included 50 patients diagnosed with recurrent pilonidal sinus disease, who were randomly allocated into two groups: Group A, which comprised 25 patients treated with a modified Limberg flap (MLF), and Group B, which included 25 patients managed with a modified elliptical rotational flap (MERF). Patients of both genders with a diagnosis of recurrent pilonidal sinus within two years and not more than one recurrence were eligible for inclusion. Exclusion criteria were primary pilonidal sinus disease, contraindications to surgery such as bleeding tendency or significant cardiopulmonary disorders, and a history of previous flap surgery. Written informed consent was obtained from all patients following full explanation of the study objectives and procedures. The study protocol was approved by the Research Ethical Committee of the Faculty of Medicine, October 6 University.

The required sample size was determined using the OpenEpi program, with a confidence level of 95%, test power of 80%, and a significance level of 0.05. Based on these parameters, a total of 50 cases was calculated, with 25 patients allocated to each study arm. All eligible patients were consecutively enrolled until the target number was reached. Demographic characteristics, clinical history, operative details, and postoperative outcomes were recorded for all cases using standardized forms and validated assessment tools. Data collection included gender, prior history of pilonidal sinus disease, infection status (acute or chronic), number of recurrences, risk factors for recurrence, and comorbid conditions.

Before surgery, all patients underwent routine preoperative assessment including complete blood count, coagulation profile, erythrocyte sedimentation rate, renal function, and liver function tests. Hair removal of the sacrococcygeal area was performed one day before the operation. All patients received intravenous prophylaxis with 1 g of cefazolin prior to incision. Surgical procedures were performed with the patients positioned in the jack-knife position, and the buttocks were separated with adhesive tape for better exposure.

The skin was disinfected with 10% povidone-iodine, and methylene blue was injected into sinus openings to delineate tracks and extensions.In the modified Limberg flap, A rhomboid excision was drawn with the inferior apex placed 1.5–2 cm lateral to the midline on the side opposite to the donor flap. A fasciocutaneous flap was elevated from the gluteal fascia while carefully preserving vascular connections from the subdermal plexus and perforators of the superior and inferior gluteal arteries. The flap was transposed medially to cover the defect without tension. Subcutaneous layers were closed with interrupted 2-0 vicryl sutures over a suction drain, and the skin was closed with 2-0 proline sutures, which were removed on postoperative day 14. Using the opposite-sided flap was emphasized as a critical step to flatten the natal cleft and reduce recurrence (Figure 1, 2, 3, 4 and 5).

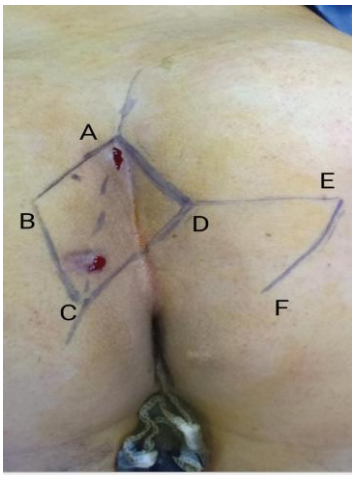

Figure 1: Preoperative marking for the modified Limberg flap. the lower angle of the rhomboid was shifted off the midline, 2 cm to the right.

Figure 2: Excision of pilonidal sinus

Figure 3: after moblization of modified Limberg flap

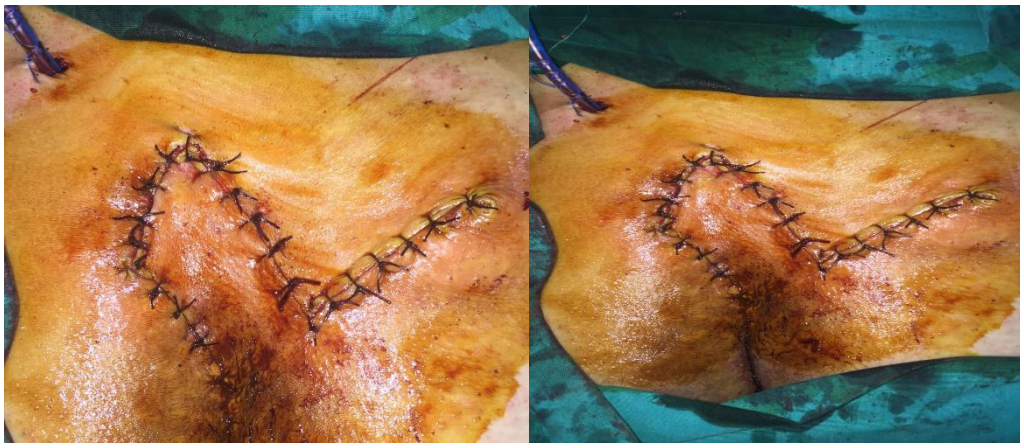

Figure 4: After suturing the flap

Figure 5: few days postoperatively

In the modified elliptical rotational flap technique, an elliptical flap equal in size to the excised area was designed with a broad base to maintain adequate perfusion via the subdermal and dermal plexuses. Additional support was provided by perforating branches of the gluteal arteries. The flap was rotated to cover the post-sacral defect and fixed to the fascia with interrupted 2-0 vicryl sutures. Subcutaneous layers were closed with 3-0 vicryl, and the skin was approximated with either 3-0 prolene or staples. Closed suction drains were routinely placed in both groups to standardize postoperative care.

Figure 6: Preoperative marking for MERF

Figure 7: Operative Marking of MERF

Figure 8: after suturing the flap

Figure 9: Post-operative follow up

Postoperatively, drains were removed when daily drainage decreased to 20 ml or less. Patients were evaluated clinically on postoperative days 2, 7, 10, and 14, when wound inspection and suture removal were performed. At one month, cosmetic satisfaction was assessed subjectively by patients using a 10-point scale, with scores of 8–10 considered good, 5–7 moderate, and 1–4 poor. Seroma was defined as a non-infected fluid collection beneath the flap detected by clinical examination, while infection was defined as purulent discharge from the wound. All follow-up assessments were performed by a surgeon blinded to the type of surgical procedure. Operations were carried out by senior surgeons, each with experience of more than 100 pilonidal sinus surgeries. Patients were followed for a period of 24 months to monitor complications and recurrence.

An essential element of postoperative management was long-term hair control, as loose hair shafts are recognized as a major cause of recurrence by penetrating healing tissue and inducing chronic inflammation. Conventional hair removal methods such as shaving and depilatory creams were discussed, but shaving may induce microtrauma and irritation, while depilatory creams may cause allergic reactions. Trimming or clipping on a weekly or biweekly basis was recommended as a safer alternative. However, laser hair epilation has recently emerged as the preferred method, providing durable reduction in hair density, improved hygiene, and lower recurrence rates. Studies show recurrence rates below 10% with laser epilation compared with over 40–50% in patients without hair control. Standard protocols typically involve four to eight laser sessions at intervals of four to six weeks, with maintenance sessions as needed.

All data were entered and analyzed using the Statistical Package for the Social Sciences (SPSS) version 20. Quantitative variables were expressed as mean ± standard deviation, while qualitative variables were presented as numbers and percentages. Chi-square or Fisher's exact test was applied for categorical data. Comparisons of means between two groups were made using the independent sample t-test when normally distributed, while the Mann–Whitney test was applied for non-parametric data. A p-value less than 0.05 was considered statistically significant, and a value less than 0.001 was considered highly significant

3. RESULTS

1. Demographic Data

As for gender distribution: In the group with prior open method (n = 30) there are 24 patients were males and 6 patients were females. While in the group with prior closed method (n = 20): there are 18 patients were males and 2 patients were females.Overall, the condition showed a male predominance, with 42 males (84%) and 8 females (16%). In addition, 18 patients (36%) had undergone one previous surgical intervention, most commonly simple excision with or without primary closure. This reflects the recurrent and persistent nature of the disease and the limitations of conventional surgical approaches in preventing recurrence .The duration of symptoms before the most recent surgical intervention ranged from 6 months to 2 years, indicating a chronic course in many cases.

2. Operative Outcomes

Total of 50 patients were included in this study, with 25 patients in each group (MLF and MERF). The comparison of quantitative outcomes between the two groups is summarized in (Table 1). Including operative time ,healing time ,back to work, patient satisfaction , cosmetic results and recurrence rate.

The operative time was significantly longer in the MERF group (90 ± 10 minutes) compared to the MLF group (60 ± 5 minutes) ($p < 0.001$). In contrast, the healing time was significantly shorter in the MERF group (15 ± 2 days) compared to the MLF group (20 ± 4 days) ($p < 0.0001$). Similarly, patients in the MERF group returned to work earlier (22± 4 days) than those in the MLF group (26± 5 days) ($p < 0.007$).Patient satisfaction was assessed using a Numerical Rating Scale (NRS) ranging from 1 to 10, where higher scores indicated greater satisfaction. The MERF group reported significantly higher satisfaction scores (8.7 ± 0.8) compared to the MLF group (6.5 ± 1.2) ($p < 0.001$) as in (table 2).Cosmetic outcome was also evaluated using a patient-reported NRS (1–10), with the MERF group scoring significantly higher (9.0 ± 0.9) than the MLF group (6.0 ± 1.5) ($p < 0.001$), indicating superior cosmetic satisfaction.as in(table 3)

Regarding recurrence rates, the MLF group experienced 3 recurrences (12%), while the MERF group had 1 recurrence (4%). However, this difference was not statistically significant ($p = 0.609$) as in(table 4)

Table (1) Comparison of Quantitative Outcomes Between MLF and MERF

Outcome	MLF (Mean ± SD)	MERF (Mean ± SD)	p-value	Interpretation
Operative Time (min)	60 ± 5	90 ± 10	< 0.001	MERF longer
Healing Time (days)	20 ± 4	15 ± 2	<0.0001	MERF faster
Return to Work (days)	26 ± 5	22 ± 4	0.007	MERF earlier
Patient Satisfaction (1–10)	6.5 ± 1.2	8.7 ± 0.8	< 0.001	MERF higher
Cosmetic Score (1–10)	6.0 ± 1.5	9.0 ± 0.9	< 0.001	MERF superior

Table (2) Satisfaction of MLF and MERF

MLF		MERF	
Patient No.	**Satisfaction Score**	**Patient No.**	**Satisfaction Score**
1	9.5	1	7.2
2	8.6	2	6.8
3	9.1	3	5.9
4	7.9	4	6.1
5	8.8	5	7.4
6	9.2	6	6.3
7	8.4	7	5.7
8	8.9	8	6.6
9	9	9	7.5
10	8.3	10	6.0
11	8.5	11	5.8
12	8.3	12	6.9
13	7.8	13	7.1
14	8.7	14	6.2
15	9.1	15	5.5
16	8.6	16	7
17	8.2	17	6.7
18	9.4	18	5.6
19	8.8	19	6.4
20	8.5	20	7.3
21	8.9	21	6.1
22	9	22	5.4
23	8.1	23	6.8
24	9.2	24	7.6
25	8.4	25	6

High satisfaction (8-10); Moderate satisfaction (5-7); Low satisfaction (1-4)

Table (3) Cosmetic Score (NRS) of MLF and MERF

MLF		MERF	
Patient No.	**Cosmetic Score**	**Patient No.**	**Cosmetic Score**
1	9	1	6
2	8	2	7
3	10	3	5
4	9	4	6
5	8	5	8
6	9	6	4
7	10	7	6
8	9	8	7
9	10	9	5
10	8	10	6
11	9	11	3
12	9	12	7
13	10	13	6
14	7	14	5

15	8	15	5
16	9	16	4
17	10	17	6
18	9	18	7
19	8	19	5
20	9	20	6
21	10	21	9
22	9	22	5
23	8	23	6
24	9	24	7
25	9	25	4

Good (8-10); Moderate (5-7); Bad (1-4)

Table (4) Recurrence Rate Between MLF and MERF

Group	Number of Recurrences	Percentage (%)	p-value
MLF	3/25	12%	0.609
MERF	1/25	4%	

3. Complications

The postoperative complications are summarized in Table 5. No statistically significant differences were found for any of the complications (all $p > 0.005$). The most common complications in both groups were numbness (28% in MLF vs. 36% in MERF) and tightness (20% in MLF vs. 16% in MERF). Wound infection rates were slightly higher in the MERF group (20% vs. 12% in MLF), while flap ischemia was more common in the MLF group (12% vs. 4% in MERF). However, these differences did not reach statistical significance. Wound dehiscence occurred at the same rate (8%) in both groups. Seroma formation was slightly more frequent in the MLF group (20% vs. 16% in MERF), but this difference was not statistically significant (Table 5).

Table (5) Complications for the included patient in both groups

Postoperative Complications	MLF N = 25	MERF N = 25	P value
Tightness	5 (20%)	4 (16%)	> 0.08
Numbness	7 (28%)	9 (36%)	> 0.809
Wound infection	3 (12%)	5 (20%)	> 0.232
Wound dehiscence	2 (8%)	2 (8%)	> 0.224
Seroma	5 (20%)	4 (16%)	> 0.942
Flap ischemia	3 (12%)	1 (4%)	> 0.293

4. DISCUSSION

Pilonidal sinus disease (PSD) is a significant healthcare problem, particularly affecting young adults, with an annual incidence of 26 per 10,000 individuals **[7].** The chronic and recurrent nature of PSD often leads to multiple surgical interventions, resulting in prolonged disability, economic strain, and decreased quality of life. Patients frequently suffer from pain, discomfort, and social limitations. Thus, optimizing surgical management to minimize recurrence, enhance healing, and improve patient satisfaction is of considerable importance.

Meta-analyses have confirmed that both the Modified Limberg Flap (MLF) and the Modified Elliptical Rotational Flap (MERF) are associated with low recurrence rates comparable to other off-midline closure techniques **[8].** MLF in particular has demonstrated durability with longer follow-up, lower rates of wound complications, and faster healing compared with traditional Limberg and Karydakis flaps. In this context, the present study directly compared MLF and MERF in recurrent PSD cases, assessing operative time, healing, return to work, cosmetic satisfaction, recurrence, and postoperative complications.

Although the MERF procedure required significantly longer operative time, it was associated with superior healing, quicker return to work, better cosmetic outcomes, and higher overall patient satisfaction. The prolonged operative time is attributable to the wider dissection and tissue mobilization inherent to rotational flap techniques, yet these disadvantages were offset by improved recovery and socioeconomic benefits. Patient satisfaction scores, measured using a Numerical Rating Scale (NRS), were markedly higher in the MERF group, likely reflecting both the better cosmetic results and faster resumption of daily activities. The cosmetic advantage of MERF may be explained by its more natural tissue alignment and lower closure tension. While recurrence was lower in the MERF group (4%) compared to the MLF group (12%), the difference was not statistically significant, likely due to the limited sample size.

Our study revealed a statistically significant difference in operative duration between groups: MLF averaged 60 ± 5 minutes versus 90 ± 10 minutes for MERF ($p < 0.001$). This contrasts with some previous reports. As described shorter operative times for both techniques, with MERF being faster than MLF **[9].** Similarly, reported shorter mean operative times for MERF **[10, 11].** By contrast, reported mean operative times for MLF comparable to ours. The relatively prolonged duration in the present study likely reflects the technical difficulty of operating on recurrent cases, which are characterized by dense scarring, fibrosis, distorted tissue planes, and multiple tracts. Radical excision of diseased tissue was deliberately performed to minimize re-recurrence, inevitably lengthening operative steps. Additionally, meticulous hemostasis was emphasized to prevent hematoma in vascularized scar tissue, further prolonging operative time. Importantly, longer duration in recurrent PSD should not be viewed as a drawback but as an indicator of surgical precision **[7].**

Healing time showed the opposite pattern. The MLF group required a mean of 20 ± 4 days, whereas MERF patients healed in 15 ± 2 days ($p < 0.0001$). This demonstrates the advantage of MERF in promoting quicker recovery. Healing times vary in the literature. As observed shorter healing periods in MLF **[12]** than we reported, while another study found MERF averaged 16 days **[13].** Similarly reported faster MLF healing. Differences between studies likely relate to patient selection, surgical technique, and postoperative care **[7].** Our stricter excision and follow-up may explain slightly longer healing in MLF, while the shorter MERF healing reflects both its flap design and improved perioperative management.

Regarding return to work, MERF patients resumed normal activity in 22 ± 4 days, significantly earlier than the MLF group (26 ± 5 days; $p < 0.007$). This is consistent with reports also noted faster return after MERF. Shorter recovery is clinically and economically significant, reducing productivity loss **[11].** Previous studies reported variable times: found MLF patients returned after ~17 days **[12]**, while MERF patients required ~19 days **[10]**. Differences reflect heterogeneity in patient occupation, lifestyle, and institutional protocols.

Patient satisfaction and cosmetic results favored MERF. The mean NRS satisfaction score was 8.7 ± 0.8 in MERF versus 6.5 ± 1.2 in MLF ($p < 0.001$). Cosmetic scores were also significantly higher in MERF, likely due to the preservation of gluteal contour and tension-free closure. Khalid et al. reported favorable satisfaction in MLF patients, yet less pronounced than our MERF findings **[12]**. Similarly documented higher satisfaction in MERF patients **[9]**. Other studies confirm the association of MERF with higher cosmetic and functional satisfaction. Although contradictory findings exist, the holistic perspective suggests MERF may provide superior outcomes, particularly in recurrent disease **[13, 14].**

Recurrence in our series was 12% for MLF and 4% for MERF. Two MLF patients recurred within a year, both with dense hair and poor adherence to hair removal. Another MLF patient developed recurrence two years later. In the MERF group, one patient had a superficial recurrence at seven months, managed successfully with sinus curettage and phenol application. Although the recurrence difference was not statistically significant ($p = 0.092$), the trend suggests MERF may be more durable in recurrent disease, echoing findings observed recurrences only in the MLF group. Importantly, recurrence in our cohort was closely associated with inadequate postoperative hygiene and hair control, reinforcing the necessity of strict long-term preventive measures **[9].**

Postoperative complications were observed in both groups with no statistically significant differences. In MLF, rates were 20% tightness, 28% numbness, 12% infection, 8% dehiscence, 20% seroma, and 12% flap ischemia. In MERF, rates were 16% tightness, 36% numbness, 20% infection, 8% dehiscence, 16% seroma, and 4% ischemia. While the MERF group had more numbness and infections, flap ischemia was lower compared with MLF. These differences, however, were not significant.

Complications were generally minor and managed conservatively. Tightness occurred in both groups, usually transient and improving with physiotherapy, scar management, and reassurance. Persistent tightness was rare and resolved with conservative measures. Numbness was also common, reflecting sensory nerve involvement during flap dissection, and typically improved over time with vitamin supplementation, desensitization therapy, and reassurance. A small proportion

experienced persistent numbness beyond six months but without functional limitations.

Wound infection occurred in both groups, managed with antibiotics, dressings, or minor drainage. All cases resolved without major sequelae. Seroma was one of the most common complications, requiring aspiration or drainage in some cases but resolving without recurrence. Wound dehiscence was observed in a few cases, managed conservatively or with secondary suturing. Flap ischemia, though rare, was more common in MLF. In our series, ischemia ranged from superficial epidermolysis to partial necrosis, treated with local care or minor revision. MERF ischemia was minimal, with one case responding to conservative measures.

These findings are comparable with published series. Although, reported low complication rates with MLF, primarily seroma and hematoma **[12]**. As observed minimal recurrence or necrosis in MERF **[15]**. Wound infection rates lower in MERF than MLF, consistent with our trends **[10]**. Reported dehiscence and infection higher in MLF, echoing our results **[13]**. Also highlighted lower recurrence and complication rates in MLF compared to classical Limberg and Karydakis, yet our findings suggest MERF offers an additional advantage in recurrent disease **[16].**

5. CONCLUSION

Due to its great postoperative quality of life, low recurrence rate, and few complications, MLF reconstruction is a frequently done technique for pilonidal sinus illness. According to our cross sectional study, the modified elliptical rotation flap technique yields better postoperative outcomes, patient satisfaction, recurrence rates, and complications than the MLF repair. Furthermore, both procedures proved effective in treating PSD because of comparable complication profiles and low recurrence rates. However, the choice between MLF and MERF should be tailored to individual patient factors, surgeon expertise, and specific treatment goals. Future research should focus on long-term outcomes, quality of life measures, and a deeper investigation of the factors influencing patient satisfaction beyond cosmetic results.

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