

## ORIGINAL RESEARCH

# Karydakis Versus Limberg Flap in Primary Sacrococcygeal Pilonidal Sinus: A Retrospective Comparative Study of Functional Recovery

Tamer A. A. M. Habeeb<sup>1</sup> | Abdulzahra Hussain<sup>2,3</sup>  | Jose Bueno-Lledó<sup>4</sup> | Mariano Eduardo Giménez<sup>5,6</sup> | Alberto Aiolfi<sup>7</sup> | Ahmed Abdelsamad<sup>8</sup>  | Massimo Chiaretti<sup>9</sup> | Igor A. Kryvoruchko<sup>10</sup>  | Mallikarjuna N. Manangi<sup>11</sup> | Nasreldin Mohammed Algalaly<sup>12</sup> | Mohammed Abbas<sup>12</sup> | Mohamed Fathy Labib<sup>12</sup> | Osama Almezaen<sup>12</sup>  | Mohamed Hassan Mohamed Elkaseer<sup>12</sup> | Hamada Rashad Mohamed Abdelkader<sup>12</sup> | Mohamed Swelam<sup>12</sup> | Mahmoud E. Nagaty<sup>12</sup> | Mahmoud Abd Alhady Abd Alaziz Abd Alhady<sup>12</sup> | Mohamed Ibrahim Henish<sup>12</sup> | Hamdy Farag<sup>12</sup> | Mohamed Ibrahim Shalamesh<sup>12</sup> | Ibtisam AbdElMaksoud Mohamed El Shamy<sup>13</sup> | Alaa A. Fiad<sup>1</sup> | Hamdi Elbelkasi<sup>14</sup> | Mohamed Ibrahim Abo Alsaad<sup>15</sup> | Mahmoud Moustafa AL-Shareef<sup>16</sup> | Mahmoud Abdelnasser Eissa<sup>16</sup> | Mahmoud Elghonimy Abd Elsadek<sup>16</sup> | Abouelatta K. H. Ali<sup>17</sup> | Maged Z. Youssef<sup>18</sup> | Mohamed Abdelbar Mohamed<sup>19</sup>  | Ahmed Hamdy<sup>20</sup> | Ali Hussein Khedr<sup>21</sup> | Ayman A. Khater<sup>22</sup> | Hazem E. Ali<sup>22</sup> | Mohammed Siam<sup>23</sup> | Mohamad Naeem Elnahas<sup>24</sup> | Mohamed Adel Saqr<sup>25</sup> | Mostafa Fathy Ibrahim Ahmed<sup>26</sup> | Mohamed Mahmoud Mokhtar Mohamed<sup>1</sup> | Mohamed Elnemr<sup>1</sup> | Bassam Mousa<sup>1</sup>  | Tamer Wasefy<sup>1</sup> | Ahmed M. El Teliti<sup>1</sup> | Mohamed Abozaid<sup>1</sup> | Adel Morsi<sup>1</sup> | Taha A. Biomy<sup>1</sup> | Baher Atef<sup>1</sup> | Mohamed Mahmoud Almenaiwy<sup>1</sup> | Mohamad S. Moussa<sup>1</sup> | Mohamed H. Hebeishy<sup>1</sup> | Hasnaa Metwally<sup>1</sup> | Mohamed S. Bayomi<sup>1</sup> | Abdelshafy Mostafa<sup>1</sup> | Ahmed Attia Saleh<sup>1</sup> | Mahmoud Abdou Yassin<sup>1</sup>

<sup>1</sup>Department of General Surgery, Faculty of Medicine, Zagazig University, Zagazig, Egypt | <sup>2</sup>Sheffield University, Sheffield, UK | <sup>3</sup>University of Alkafeel, Kufa, Iraq | <sup>4</sup>Hospital Universitari i Politècnic la Fe, Valencia, Spain | <sup>5</sup>University of Strasbourg, Strasbourg, France | <sup>6</sup>Scientific Director of Percutaneous Surgery, IHU-IRCAD, Strasbourg, France | <sup>7</sup>Division of General Surgery, Department of Biomedical Science for Health, I.R.C.C.S. Ospedale Galeazzi-Sant'Ambrogio, University of Milan, Milan, Italy | <sup>8</sup>Department of Surgery II, University of Witten/Herdecke, Witten, Germany | <sup>9</sup>Department of General Surgery Specialties and Organ Transplant, Faculty of Pharmacy and Medicine, Sapienza Rome University, Rome, Italy | <sup>10</sup>Department of Surgery No.2, Kharkiv National Medical University, Kharkiv, Ukraine | <sup>11</sup>Department of General Surgery, Bengaluru, India | <sup>12</sup>General Surgery Department, Faculty of Medicine, Al-Azhar University, Cairo, Egypt | <sup>13</sup>Department of General Surgery, Faculty of Medicine for Girls, Cairo Al Azhar University, Cairo, Egypt | <sup>14</sup>Mataryia Teaching Hospital (GOTHI), Cairo, Egypt | <sup>15</sup>General Surgery Department-Faculty of Medicine, Merit University, Sohag, Egypt | <sup>16</sup>Department of General Surgery, Faculty of Medicine, Tanta University, Tanta, Egypt | <sup>17</sup>Misr University for Science and Technology, Cairo, Egypt | <sup>18</sup>Department of General Surgery, Faculty of Medicine, October 6 University, 6th of October City, Egypt | <sup>19</sup>Department of General Surgery, Faculty of Medicine, Luxor University, Luxor, Egypt | <sup>20</sup>Department of Hepato-Bilio-Pancreatic (HBP) Surgery, National Hepatology and Tropical Medicine Research Institute, Cairo, Egypt | <sup>21</sup>Department of Surgery National Hepatology and Tropical Medicine Research Institute (-NHTMRI), Cairo, Egypt | <sup>22</sup>Department of General Surgery, Faculty of Medicine, Benha University, Benha, Egypt | <sup>23</sup>Department of General Surgery, Faculty of Medicine, Suez University, Suez, Egypt | <sup>24</sup>Plastic Surgery Department, Faculty of Medicine, Shebin Teaching Hospital, Menoufia, Egypt | <sup>25</sup>Plastic and Reconstructive Surgery Department, Faculty of Medicine, Zagazig University, Zagazig, Egypt | <sup>26</sup>Plastic Surgery Department, Faculty of Medicine, Benisuef University, Beni Suef, Egypt

**Correspondence:** Tamer A. A. M. Habeeb ([tameralnaimy@hotmail.com](mailto:tameralnaimy@hotmail.com))

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## ABSTRACT

**Background:** Successful surgical management of pilonidal sinus disease (PSD) in young, active patients requires rapid restoration of daily functions, including driving and sexual activity. This study compared patient-reported recovery as regards sexual function and driving ability following the KF versus the LF for primary sacrococcygeal PSD.

**Methods:** This multicenter retrospective cohort study (FLARE study) included employed, sexually active patients who underwent surgery for primary PSD (July 2017–July 2024). The primary outcome was time to sexual activity resumption; the secondary outcome was time to resumption of driving. Outcomes were assessed at 1 year using a structured Likert-scale questionnaire. Kaplan-Meier curves and Cox regression analyses with adjustment were used.

**Results:** A total of 352 patients were divided into 176 KF and 176 LF. KF patients resumed sexual activity earlier ( $2.88 \pm 0.7$  vs.  $4.58 \pm 1.1$  weeks; mean difference  $-1.7$  weeks, 95% CI  $-1.89$  to  $-1.49$ ,  $p < 0.001$ ). KF reported significantly less pain, less avoidance, and lower analgesic use during sex. LF reported lower sexual satisfaction (mean 3.94 vs. 2.15; mean difference  $-1.78$ , 95% CI  $-2.02$  to  $-1.53$ ). KF resumed driving earlier (median 9 vs. 19 days;  $r = 0.7$ , large effect,  $p < 0.001$ ) and had longer sitting tolerance (OR 0.3, 95% CI 0.2–0.4,  $p < 0.001$ ). LF had higher pain while sitting (mean Likert 4 vs. 2; mean difference of  $-1.94$ , 95% CI  $-2.19$  to  $-1.68$ ), higher VAS pain (median 4 vs. 2;  $r = 0.5$ ), greater need for cushions/analgesics, and more driving-related work/social limitations (all  $p < 0.001$ ). Time to resume sexual activity and driving was significantly shorter for KF. On multivariable analysis, LF was independently associated with delayed return to sexual activity (adjusted OR 4.02, 95% CI 2.1–7.5,  $p < 0.001$ ) and delayed return to driving (adjusted OR 2.8, 95% CI 1.5–5.2,  $p < 0.001$ ).

**Conclusions:** In this retrospective cohort, KF may be associated with significantly faster return to sexual and driving activity compared with LF. These results underscore the importance of incorporating patient-centered functional outcomes into surgical decision-making for PSD.

**Trial Registration:** Number: NCT07271537.

## 1 | Introduction

The sacrococcygeal region is the principal site for pilonidal sinus disease (PSD), a chronic inflammatory disorder demonstrating a pronounced incidence in young, active male/female populations [1–3]. The global incidence of PSD varies, with an average of 26/100,000, rising to nearly 8.8% in specific populations [4, 5]. The development of PSD involves the occlusion of hair follicles in the natal cleft, chronic sinus tract formation, and recurrent abscesses. These manifestations cause pain and a reduction in quality of life (QOL) [2, 6]. PSD may rarely show malignant transformation [7]. The etiology of PSD is an acquired multifactorial disease [8]. Several risk factors for PSD include young male, poor hygiene, high body mass index, familial history, deep natal cleft, and lifestyle factors such as prolonged sitting (e.g., driving) and local skin irritation [2, 8]. Therefore, although PSD is a benign condition, it can interfere with daily functions, especially in individuals with seated occupations or concerns regarding physical intimacy.

For chronic PSD, surgical management is the definitive treatment. The goal of surgery is the complete excision of the sinus tracts to minimize the risk of recurrence and enable a rapid return to normal daily activities. Many surgical approaches have been developed, including multiple z-plasty under local anesthesia [9], lay open [10], phenolization [11], midline unshifted adipofascial turnover flap or midline shifted adipofascial turnover flap [12], endoscopic treatment [13, 14], platelet-rich plasma [15], laser therapy [16, 17], oval advancement flap design [18], simple excision and primary closure [19], and complex flap-based reconstructions [20, 21]. The lay-open excision procedure is associated with prolonged, specialized postoperative nursing management [22, 23]. Increasing evidence showed that flap closure techniques yield recurrence rates comparable to those of the lay-open procedure while also promoting wound healing and a rapid return to daily duties [24]. The Karydakias flap (KF) and Limberg flaps (LF) are

among the commonly used off-midline closure techniques. Both techniques have demonstrated good postoperative results in terms of wound complications and recurrence [20]; however, there is still debate about the best approach, especially patient-centered functional outcomes. The assessment of surgical outcomes for PSD has historically focused on recurrence and wound healing [25]; however, for the young and active PSD patient, a rapid return to sexual and driving ability is a crucial indicator of the success of surgery [26]. Therefore, various flap-based techniques have been developed to achieve this purpose [4].

There is a lack of literature directly comparing sexual and driving function outcomes between LF and KF procedures using structured instruments. This gap is important because most people with PSD are sexually active when they are diagnosed [27]. To resolve this, our study specifically evaluated patient-centered functional recovery outcomes, including sexual activity and driving ability, between KF and LF techniques, which have not been systematically assessed in previous literature.

## 2 | Methods

### 2.1 | Study Design and Eligibility Criteria

Patients aged  $\geq 18$  years who were sexually active, employed, or driving and diagnosed with primary sacrococcygeal symptomatic PSD based on clinical aspects, and physical examination [23, 28] underwent KF and LF according to the guidelines [23] were enrolled in the FLARE Study (FLap surgery And functional Recovery in PSD). Between July 2017 and July 2024 were consecutively included in this retrospective study. Figure 1 shows a flowchart of the inclusion and exclusion criteria. This study was designed in accordance with the principles of the Declaration of Helsinki and the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement, and approval was granted by the Institutional Review Board (No. 1833).

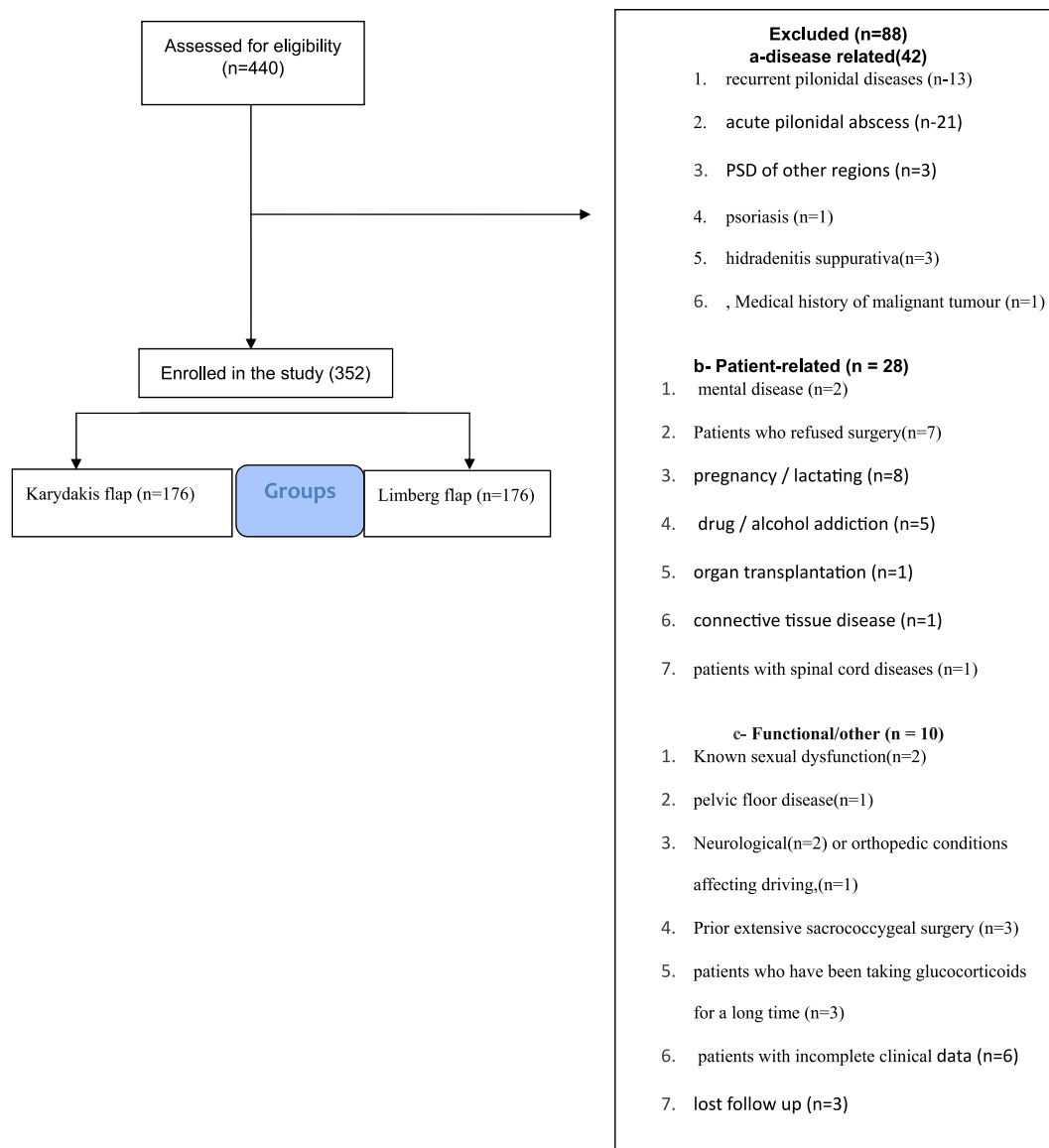


**FIGURE 1** | STROBE-compliant flow diagram of patient selection (inclusion and exclusion criteria).

## 2.2 | Participating Centers, Surgeon Experience, Surgical Allocation Criteria, and Standardization of Protocol

Nine affiliated hospitals in Egypt shared in patient recruitment. The surgeon's preference determined the choice of surgical technique, the disease's anatomical characteristics, and institutional practice patterns. Factors influencing surgical selection included the number and distribution of sinus tracts, the distance from the midline, the extent of inflammation, and the expected defect size. To minimize selection and performance bias, all participating centers followed standardized preoperative evaluation protocols and postoperative follow-up, and both procedures were performed by experienced consultant-level surgeons familiar with both techniques. Our Surgeons' experience was defined as a Minimum of 5 years of independent

surgical practice and experience performing at least 30 KF or LF procedures prior to study initiation.

## 2.3 | Variables Collection

Data were collected from the surgical sheets and logs. Data collected included age, sex, smoking, DM (Diabetes mellitus), BMI (Body mass index), Symptoms before surgery, etiology of the PSD, time from abscess drainage until fistula diagnosis (months), duration from fistula diagnosis until surgery (months), number of tracts, position of opening, Tezel classification, distance between sinus opening and midline (cm), length of tract (cm), sinus opening diameter (mm), inflammatory mass, size of inflammatory mass (mm), operative time (minutes), specimen volume (cm<sup>3</sup>), post-operative hospitalization (days), postoperative complications,

Clavien-Dindo classification (CD), visual analog score (VAS), recurrence [12 months after the operation], Sexual Function Questionnaire and Driving Ability Questionnaire.

## 2.4 | Definitions of Outcomes and Variable Measurements

The primary outcome was time to resumption of sexual activity (consensual, penetrative intercourse) following surgery. Sexual function was assessed using a structured 5-point Likert-scale questionnaire administered at 12 months postoperatively. Delayed return to sexual activity was defined as resumption of sexual activity beyond 4 weeks postoperatively without significant discomfort, based on clinical recovery expectations reported in previous literature [29]. The secondary outcome was time to return to driving ability following surgery. Delayed return to driving was defined as resumption of driving comfortably (first time operating a motor vehicle for a trip of at least 15 min' duration) beyond 4 weeks postoperatively without pain requiring analgesics. Patients were asked to rate their sexual and driving functions on a Likert scale ranging from 1 to 5. Strongly disagree (1 point), disagree (2 points), neutral (3 points), agree (4 points), and strongly agree (5 points). We evaluated the range ( $5-1 = 4$ ) and interval ( $4/5 = 0.80$ ). Mean values were calculated for each question in each group. The final results were calculated as follows: 1-strongly disagree (1–1.79), 2-disagree (1.80–2.59), 3-neutral (2.60–3.39), 4-agree (3.40–4.19), and 5-strongly agree (4.20–5) [Table S1]. A higher Likert score indicates a worse outcome. The postoperative complications have been defined in previous studies [30, 31]. Postoperative complications were classified according to the CD classification [32]. The VAS score was used to assess postoperative pain (range: 0–10). Local hair density and distribution were graded according to the Tezel classification [33]. The volume of the excised specimen was measured using a graduated cylinder [34]. Patients were diagnosed with a recurrence if, after complete surgical healing, they met at least one of the following criteria: a doctor's diagnosis, need for reintervention, formation of a new sinus, presence of hair in a sinus opening, or discharge of pus [35]. We evaluated recurrence at the end of the 1-year follow-up.

## 2.5 | Sample Size

As this was a retrospective study, no formal sample size calculation was performed. All consecutive eligible patients during the study period were included. The sample size was deemed adequate for multivariate analyses and to detect clinically meaningful differences.

## 2.6 | Operative Techniques

All the patients received preoperative prophylactic cefazolin (1 g). KF and LF have been previously described [36, 37]. Perioperative care was standardized for all patients. The patients were discharged based on clinical discharge criteria [38].

## 2.7 | Follow Up

Patients were followed weekly until complete wound healing and then every 3 months for 1 year. Assessments included wound inspection for recurrence, VAS for pain at discharge on days 10 and 30, and documentation of wound complications at removal of sutures and in the first 30 days. Follow-up was conducted by

telephone or clinic visits. All patients received standardized post-operative protocols, which include extensive local depilation for 3 months to prevent maceration and hair inclusion, with a recommendation for permanent laser hair removal, smoking cessation from 1 month before to 1 month after surgery [39, 40]; and strict wound hygiene to minimize complications [41]. After 1 year, the patients were asked to complete a structured sexual and driving function Likert scale questionnaire. The questionnaires were administered in the native languages of the participating centers, using harmonized wording to ensure consistent interpretation across sites. The English version was translated into Arabic by two independent bilingual translators, reconciled, and back-translated. The Arabic version was pilot-tested with 10 post-operative patients to assess comprehension and clarity, with no modifications required. The questionnaires were administered through structured follow-up, including outpatient clinic visits or telephone interviews when in-person follow-up was not feasible. This approach ensured consistent data collection across all participating centers. Basic linguistic adaptation was performed to ensure clarity and comprehension in different settings.

## 2.8 | Statistical Analysis

Statistical analyses were conducted using SPSS version 28.0 (IBM Corp.). Normality was assessed using the Kolmogorov-Smirnov test. Data are presented as frequencies with percentages for categorical variables and as means  $\pm$  standard deviations or medians with interquartile ranges for continuous variables. Intergroup comparisons were performed using the *t*-test or the Mann-Whitney test for continuous variables and the chi-square test for categorical variables. The questionnaire's internal consistency was assessed using Cronbach's alpha. A value of  $\geq 0.70$  was considered acceptable. The structured, standardized questionnaires demonstrated good internal consistency, with Cronbach's alpha of 0.84 for sexual function-related items and 0.81 for driving-related items. Missing responses were handled using complete-case analysis. Cases with incomplete key outcome data were excluded from specific analyses. Time for the resumption of sexual activity and driving were analyzed using Kaplan-Meier curves, and overall comparisons were done using Log Rank (Mantel-Cox), Breslow (Generalized Wilcoxon), and Tarone-Ware. Cox regression tables for sexual function and driving ability were added. The baseline covariate differences underscore the importance of adjusted analyses to isolate the effect of surgical technique from pre-existing disease characteristics. Multivariable logistic regression was used to estimate effect sizes, control for confounders, and predict risk factors for delayed return to sexual activity and driving ability. Effect sizes for Mann-Whitney comparisons were estimated using the rank-biserial correlation (*r*) and interpreted according to Cohen's criteria. Results were reported as odds ratios (ORs) with 95% confidence intervals. Statistical significance was set at  $p < 0.05$ .

## 3 | Results

### 3.1 | Patient Demographic and Baseline Characteristics

A total of 352 patients were enrolled; 176 underwent KF repair, and 176 underwent LF repair. The two groups were similar with respect to demographic characteristics (age, sex, smoking status, BMI, diabetes) and several disease-related characteristics (preoperative

symptoms, etiology, number of tracts, position of the sinus opening, Tezel classification, and sinus opening diameter) (all  $p > 0.05$ ). However, several disease characteristics differed significantly between groups: patients undergoing KF had a shorter median time from abscess drainage to diagnosis (4 (3.5–6) versus 4.7 (3–6) days,  $p = 0.002$ ) and a shorter median duration from fistula diagnosis till surgery (4 (2.2–5.6) versus 4.9 (3–6.9) days,  $p < 0.001$ ) and a longer distance between the sinus opening and midline ( $2.91 \pm 1.06$  cm vs.  $2.28 \pm 0.7$  cm;  $p = 0.02$ ), whereas tract length was longer in the LF ( $5.11 \pm 0.7$  cm vs.  $4.84 \pm 0.8$  cm;  $p = 0.001$ ). These baseline differences underscore the importance of adjusted analyses to isolate the effect of surgical technique from pre-existing disease characteristics [Table 1].

### 3.2 | Intraoperative and Postoperative Data

LF shows significantly longer operative time ( $77.9 \pm 13.4$  min vs.  $66.2 \pm 16.5$  min;  $p < 0.001$ ), larger resected specimen volume ( $8.80 \pm 1.5$  cm<sup>3</sup> vs.  $8.08 \pm 1.5$  cm<sup>3</sup>;  $p < 0.001$ ) and longer postoperative hospitalization duration (3 (3–4) vs. 3 (2–4),  $p = 0.03$ ). The overall proportion of patients experiencing postoperative complications was similar between groups (10.8% in KF vs. 7.4% in LF,  $p = 0.5$ ). Wound infection occurred in 4 patients with KF (2.3%) and 3 (1.7%). Seroma occurred in 3 KF (1.7%) and 1 LF (0.6%). Hematoma occurred in 5 patients (2.8%) in each group. Wound dehiscence occurred in 3 KF patients (1.7%) but not in any LF patients. Flap tip necrosis occurred in 1 LF patient (0.6%). Persistent hypoesthesia ( $> 3$  months) was reported in 2 KF (1.1%) and 1 LF (0.6%). When complications were graded by severity using the Clavien-Dindo classification, a significant difference emerged ( $p = 0.03$ ). Grade I complications were more common in KF (9.6% vs. 3.5%). Grade III complications (requiring surgical, endoscopic, or radiological intervention) were more common in LF (2.8% vs. 0.6%), including four patients requiring evacuation under anesthesia and one requiring flap reconstruction. The 1-year recurrence rate was not significantly different between groups (9 (5.1%) versus 12 (6.8%);  $p = 0.3$ ) [Table 2].

### 3.3 | Sexual Function Outcomes (Primary Outcome)

Table 3 presents the findings of a structured postoperative Sexual Function Questionnaire subdivided into four key domains: sexual activity resumption, physical discomfort, psychological/emotional impact, and functional/partner-related issues. Prior to surgery, sexual frequency patterns differed significantly ( $p = 0.01$ ; OR 0.6, 95% CI 0.4–0.8), with a greater proportion of LF reporting frequent weekly sexual activity. Patients in KF resumed sexual activity significantly earlier than those in the LF ( $2.88 \pm 0.7$  weeks vs.  $4.58 \pm 1.1$  weeks,  $p < 0.001$ ; mean difference  $-1.7$  weeks, 95% CI  $-1.89$  to  $-1.49$ ). There were no significant differences between the groups regarding causes that prevented patients from resuming sexual activity ( $p = 0.6$ , OR 1.04, 95% CI 0.8–1.2) or sexual positions that caused discomfort at the surgical site ( $p = 0.9$ ; OR 1.03, 95% CI 0.8–1.2). The physical domains revealed clear distinctions between groups. Across all evaluated items, the KF reported less pain at the surgical site during sexual activity (mean Likert score 2.39 vs. 3.29,  $p < 0.001$ ; mean difference  $-1.52$ , 95% CI  $-1.76$  to  $-1.29$ ), less limitation of sexual positions due to the wound or scar (mean 2.37 vs. 3.87,  $p < 0.001$ ; mean difference

$-1.47$ , 95% CI  $-1.71$  to  $-1.24$ ), lower avoidance of sexual activity due to fear of pain or wound problems (mean 2.53 vs. 3.96,  $p < 0.001$ ; mean difference  $-1.41$ , 95% CI  $-1.65$  to  $-1.18$ ), more ability to continue sexual activity from friction or pressure on the surgical area (mean 2.43 vs. 4.03,  $p < 0.001$ ; mean difference  $-1.57$ , 95% CI  $-1.81$  to  $-1.33$ ), and less use of analgesics before or after sexual intercourse postoperatively (mean 2.25 vs. 3.95,  $p < 0.001$ ; mean difference  $-1.71$ , 95% CI  $-1.95$  to  $-1.46$ ). The psychological and emotional impacts were also significantly higher following LF. Patients in the LF reported greater negative effects of body image or scarring on sexual confidence (4.11 vs. 2.35,  $p < 0.001$ ; mean difference  $-1.79$ , 95% CI  $-2.04$  to  $-1.54$ ), higher avoidance of sexual activity due to embarrassment, pain, or poor body image (3.88 vs. 2.25,  $p < 0.001$ ; mean difference  $-1.54$ , 95% CI  $-1.78$  to  $-1.30$ ), and lower sexual satisfaction after surgery than at baseline (3.94 vs. 2.15,  $p < 0.001$ ; mean difference  $-1.78$ , 95% CI  $-2.02$  to  $-1.53$ ). Functional and partner-related issues were significantly higher postoperatively in LF, concerning more frequent difficulties with arousal or maintaining arousal (3.88 vs. 2.23,  $p < 0.001$ ; mean difference  $-1.42$ , 95% CI  $-1.66$  to  $-1.19$ ), and they reported that their partners noticed changes in comfort or behavior more often during sexual activity after surgery (3.88 vs. 2.20,  $p < 0.001$ ; mean difference  $-1.53$ , 95% CI  $-1.77$  to  $-1.29$ ).

### 3.4 | Driving Ability and Function (Secondary Endpoint)

Driving ability showed significant differences in favor of the KF. Regarding the Return to Driving domain, patients in the KF resumed driving substantially earlier after surgery (9 days (5–11 days) versus 19 days (16–22 days),  $p < 0.001$ ; effect size  $r = 0.7$ , large), longer sitting tolerance while driving (44.3% can accommodate  $> 1$  h in KF and 41.5% in LF can accommodate 15–30 min before feeling discomfort,  $p < 0.001$ ; OR 0.3, 95% CI 0.2–0.4). Pain and sitting tolerance were significantly higher in the LF group. Patients with LF described higher pain feelings when sitting to drive (mean Likert 4 vs. 2,  $p < 0.001$ ; mean difference  $-1.94$ , 95% CI  $-2.19$  to  $-1.68$ ), higher median pain scores on a VAS (4 (4–5) versus 2 (1–3),  $p < 0.001$ ; effect size  $r = 0.5$ , large), higher need for a pillow or cushion to drive (mean 3.87 vs. 2.19,  $p < 0.001$ ; mean difference  $-1.53$ , 95% CI  $-1.77$  to  $-1.29$ ), higher discomfort when using seatbelts or sitting upright (mean 3.89 vs. 2.19,  $p < 0.001$ ; mean difference  $-1.51$ , 95% CI  $-1.75$  to  $-1.27$ ), and higher need for analgesics before or after driving (mean 3.85 vs. 2.04,  $p < 0.001$ ; mean difference  $-1.60$ , 95% CI  $-1.84$  to  $-1.36$ ). The confidence and recovery parameters further confirmed better outcomes in the KF. KF showed less delayed return to driving due to discomfort (mean 2.23 vs. 3.93,  $p < 0.001$ ; mean difference  $-1.50$ , 95% CI  $-1.73$  to  $-1.26$ ), more confidence while driving postoperatively (mean 2.24 vs. 3.92,  $p < 0.001$ ; mean difference  $-1.49$ , 95% CI  $-1.73$  to  $-1.26$ ), and less worry that driving could reopen or stress the surgical wound (mean 2.11 vs. 3.87,  $p < 0.001$ ; mean difference  $-1.62$ , 95% CI  $-1.86$  to  $-1.38$ ). The impact on daily life was significantly higher in the LF group. LF showed that higher driving limitations affected work or social life (mean 3.75 vs. 2.13,  $p < 0.001$ ; mean difference  $-1.32$ , 95% CI  $-1.55$  to  $-1.09$ ), and higher feeling limited in how far or how long a patient can drive (mean 3.65 vs. 2.10,  $p < 0.001$ ; mean difference  $-1.22$ , 95% CI  $-1.44$  to  $-0.99$ ) [Table 4].

**TABLE 1** | Patients' demographic and baseline characteristics in the studied groups.

|                                                            |                            | Karydakís flap (176) | Limberg flap (176) | p-value                       |
|------------------------------------------------------------|----------------------------|----------------------|--------------------|-------------------------------|
| Age                                                        |                            | 32.2 ± 5.1           | 32.3 ± 4.9         | 0.72                          |
| Sex                                                        | Male                       | 123 (69.6%)          | 128 (72.7%)        | 0.55                          |
|                                                            | Female                     | 53 (30.1%)           | 48 (27.3%)         |                               |
| Smoker                                                     | Smoker                     | 28 (15.9%)           | 32 (18.1%)         | 0.48                          |
|                                                            | Non-smoker                 | 148 (84.1%)          | 143 (81.2%)        |                               |
| DM                                                         | DM                         | 17 (9.7%)            | 15 (8.5%)          | 0.7                           |
|                                                            | Not DM                     | 159 (90.3%)          | 161 (91.5%)        |                               |
| BMI                                                        |                            | 30.07 ± 5.1          | 29.6 ± 4.7         | 0.45                          |
| Symptoms of fistula before surgery                         | Pain                       | 49 (27.8%)           | 37 (21%)           | 0.3                           |
|                                                            | Pruritus                   | 56 (31.8%)           | 64 (36.4%)         |                               |
|                                                            | Discharge and itching      | 71 (40.3%)           | 75 (42.6%)         |                               |
| Number of patients enrolled per center                     | Center 1                   | 55 (31.25%)          | 37 (21%)           | 0.5                           |
|                                                            | Center 2                   | 36 (20.45%)          | 24 (13.64%)        |                               |
|                                                            | Center 3                   | 12 (6.82%)           | 17 (9.66%)         |                               |
|                                                            | Center 4                   | 10 (5.68%)           | 20 (11.36%)        |                               |
|                                                            | Center 5                   | 12 (6.82%)           | 19 (10.80%)        |                               |
|                                                            | Center 6                   | 15 (8.52%)           | 15 (8.52%)         |                               |
|                                                            | Center 7                   | 10 (5.68%)           | 18 (10.23%)        |                               |
|                                                            | Center 8                   | 12 (6.82%)           | 17 (9.66%)         |                               |
|                                                            | Center 9                   | 14 (7.95%)           | 9 (5.11%)          |                               |
| Etiology of primary sinus                                  | Idiopathic                 | 72 (40.9%)           | 59 (33.5%)         | 0.15                          |
|                                                            | Following abscess drainage | 104 (59.1%)          | 117 (66.5%)        |                               |
| Time from abscess drainage till fistula diagnosis (months) |                            | 4 (3.5–6)            | 4.7 (3–6)          | <b>0.002<sup>a</sup></b>      |
| Duration from fistula diagnosis till surgery (months)      |                            | 4 (2.2–5.6)          | 4.9 (3–6.9)        | <b>&lt; 0.001<sup>a</sup></b> |
| Number of tract                                            | Single                     | 154 (87.5%)          | 158 (89.8%)        | 0.5                           |
|                                                            | Multiple                   | 22 (12.5%)           | 18 (10.2%)         |                               |
| Position of opening                                        | Midline                    | 158 (89.8%)          | 151 (85.8%)        | 0.2                           |
|                                                            | Lateral                    | 18 (10.2%)           | 25 (14.2%)         |                               |
| Tezel classification                                       | Type 1                     | 79 (44.9%)           | 78 (44.3%)         | 0.9                           |
|                                                            | Type 2                     | 52 (29.5%)           | 55 (31.3%)         |                               |
|                                                            | Type 3                     | 20 (11.4%)           | 22 (12.5%)         |                               |
|                                                            | Type 4                     | 25 (14.2%)           | 21 (12%)           |                               |
| Distance between sinus opening and midline (cm)            |                            | 2.91 ± 1.06          | 2.28 ± 0.7         | <b>0.02<sup>a</sup></b>       |
| Length of tract (cm)                                       |                            | 4.84 ± 0.8           | 5.11 ± 0.7         | <b>0.001<sup>a</sup></b>      |
| Sinus opening diameter (mm)                                | 1.00                       | 47 (26.7%)           | 46 (26.1%)         | 0.9                           |
|                                                            | 2.00                       | 60 (34.1%)           | 58 (33%)           |                               |
|                                                            | 3.00                       | 51 (29%)             | 54 (30.9%)         |                               |
|                                                            | 4.00                       | 18 (10.2%)           | 18 (10.2%)         |                               |

Note: Center 1: Department of General Surgery, Faculty of Medicine, Zagazig University, Zagazig, Egypt. Center 2: General Surgery Department, Faculty of Medicine, Al-Azhar University, Cairo, Egypt. The Department of General Surgery, Faculty of Medicine for Girls, Cairo Al-Azhar University, Egypt. Center 3: Mataryia Teaching Hospital (GOTH), Egypt. Center 4: Department of General Surgery, Tanta University, Tanta, Egypt. Center 5: General Surgery Department, Faculty of Medicine, Luxor University, Cairo, Egypt. Center 6: General surgery department, Faculty of medicine, Benha University. Center 7: Department of General surgery, Faculty of Medicine, Suez university, Suez, Egypt. Center 8: Plastic surgery department, faculty of medicine, Shebin teaching hospital, menoufia, Egypt. Center 9: Plastic surgery department, faculty of medicine, benisuef university, Egypt. The bold values represent statistically significant.

<sup>a</sup>Statistically significant.

### 3.5 | Kaplan-Meier Analysis (Time to Resume Sexual Activity and Driving Ability)

Figure 2 presents Kaplan–Meier survival analysis curves comparing the time to resumption of (A) sexual activity and (B)

driving ability between patients undergoing KF and those receiving LF for PSD surgery. The KM curve in Figure 2A demonstrated a significantly earlier return to sexual activity in KF than in LF. By the end of week 2, approximately 58% of

**TABLE 2** | Intraoperative and postoperative data of the studied groups.

|                                                    |                                                     | <b>Karydakis<br/>flap (176)</b> | <b>Limberg<br/>flap (176)</b> | <b>p-<br/>value</b> |
|----------------------------------------------------|-----------------------------------------------------|---------------------------------|-------------------------------|---------------------|
| Inflammatory mass                                  | Absent                                              | 106 (60.2%)                     | 105 (59.7%)                   | 0.9                 |
|                                                    | Diffuse inflammation                                | 33 (18.8%)                      | 33 (18.8%)                    |                     |
|                                                    | Focal collection                                    | 37 (21%)                        | 38 (21.5%)                    |                     |
| Size of inflammatory mass (mm)                     |                                                     | 25.50 ± 5.8                     | 26.55 ± 8.3                   | 0.53                |
| Operative time (minutes)                           |                                                     | 66.22 ± 16.5                    | 77.92 ± 13.4                  | <b>&lt; 0.001</b>   |
| Specimen volume (cm3)                              |                                                     | 8.08 ± 1.5                      | 8.80 ± 1.5                    | <b>&lt; 0.001</b>   |
| Postoperative hospitalization (days) (median, IQR) |                                                     | 3 (2–4)                         | 3 (3–4)                       | <b>0.03</b>         |
| Postoperative complications                        | No complication                                     | 157 (89.2)                      | 163 (92.6%)                   | 0.5                 |
|                                                    | Persistent hypoesthesia (> 3 months)                | 2 (1.1%)                        | 1 (0.6%)                      |                     |
|                                                    | Wound dehiscence                                    | 3 (1.7%)                        | 0 (0.00%)                     |                     |
|                                                    | Seroma                                              | 3 (1.7%)                        | 1 (0.6%)                      |                     |
|                                                    | Urinary retention                                   | 1 (0.6%)                        | 0 (0.00%)                     |                     |
|                                                    | Hematoma                                            | 5 (2.8%)                        | 5 (2.8%)                      |                     |
|                                                    | Wound infection                                     | 4 (2.3%)                        | 3 (1.7%)                      |                     |
|                                                    | Perianal edema                                      | 1 (0.6%)                        | 2 (1.1%)                      |                     |
|                                                    | Flap tip necrosis                                   | 0 (0.00%)                       | 1 (0.6%)                      |                     |
| Clavien-dindo classification                       | Grade 0                                             | 157 (89.2%)                     | 163 (92.6%)                   | <b>0.03</b>         |
|                                                    | Grade I                                             | 17 (9.6%)                       | 6 (3.5%)                      |                     |
|                                                    | Grade II                                            | 1 (0.6%)                        | 2 (1.1%)                      |                     |
|                                                    | Grade III                                           | 1 (0.6%)                        | 5 (2.8%)                      |                     |
| Treatment of postoperative complications           | No treatment                                        | 157 (89.2%)                     | 163 (92.6%)                   | 0.1                 |
|                                                    | Wound compression in bed                            | 5 (2.8%)                        | 2 (1.1%)                      |                     |
|                                                    | Open wound in bed with antibiotics                  | 7 (3.98%)                       | 3 (1.7%)                      |                     |
|                                                    | Urinary catheterization                             | 1 (0.6%)                        | 0 (0.00%)                     |                     |
|                                                    | Anti-edema and antibiotics                          | 1 (0.6%)                        | 2 (1.1%)                      |                     |
|                                                    | Evacuation under anesthesia and antibiotics         | 0 (0.00%)                       | 4 (2.3%)                      |                     |
|                                                    | Flap reconstruction                                 | 0 (0.00%)                       | 1 (0.6%)                      |                     |
|                                                    | Conservative treatment with repeated wound dressing | 3 (1.70%)                       | 0 (0.00%)                     |                     |
|                                                    | Conservative treatment with neurotonics             | 2 (1.1%)                        | 1 (0.6%)                      |                     |
| Visual analog score (median, IQR)                  |                                                     | 3.5 (3–5)                       | 6 (5–7)                       | <b>&lt; 0.001</b>   |
| Recurrence                                         |                                                     | 9 (5.1%)                        | 12 (6.8%)                     | 0.3                 |

Note: The bold values represent statistically significant.

patients in the KF had resumed sexual activity compared to only 15% in the LF. By week 4, the cumulative resumption increased to 86% for KF and 43% for LF. At 6 weeks postoperatively, > 95% of KF resumed sexual activity, in contrast to 71% in the LF. This difference was statistically significant by the log-rank test ( $p < 0.001$ ), indicating superior early recovery of sexual function in the KF.

Figure 2B shows the time for recovery of driving ability. In the first 10 postoperative days, 63% of KF patients started driving, compared with 24% in the LF group. By day 20, the cumulative driving recovery reached 87% for KF and 54% for LF. By day 30, the total driving recovery reached 96% of KF, compared to 72% in the LF. The log-rank test also showed a significant difference

( $p < 0.001$ ), favoring KF for an earlier return to driving. In Cox regression analysis, the KF group was associated with a significantly higher likelihood of earlier sexual recovery (95% CI 1.4–3.5,  $p < 0.001$ ) and driving ability (95% CI 1.5–3.5,  $p < 0.001$ ) compared with LF.

Table S2 shows Univariate and multivariate logistic regression analyses to predict delayed full return to sexual activity and delayed return to full driving ability > 4 weeks following operation. Multivariable logistic regression analysis demonstrated that LF was independently associated with delayed return to sexual activity (adjusted OR 4.02, 95% CI 2.1–7.5,  $p < 0.001$ ), representing a large effect size. Similarly, LF was associated with delayed return to driving ability (adjusted OR 2.8, 95% CI 1.5–5.2,  $p < 0.001$ ), indicating a moderate-to-large effect size. These

**TABLE 3** | Postoperative sexual function questionnaire functions in studied groups (primary outcome).

|                                                                              |                                          | Karydakis<br>flap (176) | Limberg<br>flap (176) | p-value                       | Effect size (95% CI)                    |
|------------------------------------------------------------------------------|------------------------------------------|-------------------------|-----------------------|-------------------------------|-----------------------------------------|
| Section A: Sexual activity resumption                                        |                                          |                         |                       |                               |                                         |
| Q1-Before surgery, how often were you sexually active?                       | Daily                                    | 9 (5.1%)                | 9 (5.1%)              | <b>0.01<sup>a</sup></b>       | OR 0.6, 95% CI 0.4–0.8                  |
|                                                                              | 2–3 times/week                           | 59 (33.5%)              | 47 (26.7%)            |                               |                                         |
|                                                                              | Weekly                                   | 91 (51.7%)              | 115 (65.4%)           |                               |                                         |
|                                                                              | Monthly                                  | 17 (9.7%)               | 5 (2.8%)              |                               |                                         |
| Q2-When did you resume sexual activity after surgery? (weeks)                |                                          | 2.88 ± 0.7              | 4.58 ± 1.1            | <b>&lt; 0.001<sup>a</sup></b> | Mean difference: –1.7 (–1.89 to –1.49)  |
| Q3-What prevented you from resuming sexual activity?                         | Pain                                     | 83 (47.2%)              | 47 (26.7%)            | <b>0.6</b>                    | OR 1.04, 95% CI 0.8–1.2                 |
|                                                                              | Psychological reasons (e.g., self-image) | 28 (15.9%)              | 63 (35.8%)            |                               |                                         |
|                                                                              | Fear of wound reopening                  | 33 (18.8%)              | 47 (26.7%)            |                               |                                         |
|                                                                              | No partner                               | 10 (5.7%)               | 8 (4.5%)              |                               |                                         |
|                                                                              | Others                                   | 22 (12.5%)              | 11 (6.3%)             |                               |                                         |
| Q4-Which sexual positions cause discomfort due to your surgery site?         | Lying on the back                        | 46 (26.1%)              | 46 (26.1%)            | 0.9                           | OR 1.03, 95% CI 0.8–1.2                 |
|                                                                              | Side-lying                               | 66 (37.5%)              | 61 (34.7%)            |                               |                                         |
|                                                                              | On top                                   | 34 (19.3%)              | 37 (21%)              |                               |                                         |
|                                                                              | Any pressure on the buttocks             | 19 (10.8%)              | 21 (11.9%)            |                               |                                         |
|                                                                              | All positions                            | 11 (6.3%)               | 11 (6.3%)             |                               |                                         |
| Section B: Physical discomfort                                               |                                          |                         |                       |                               |                                         |
| Q1-Do you feel pain at the surgical site during sexual activity?             | 1-Strongly disagree(1)                   | 38 (21.6%)              | 4 (2.3%)              | <b>&lt; 0.001<sup>a</sup></b> | Mean difference: –1.52 (–1.76 to –1.29) |
|                                                                              | 2-Disagree(2)                            | 65 (36.9%)              | 6 (3.4%)              |                               |                                         |
|                                                                              | 3-Neutral(3)                             | 47 (26.7%)              | 37 (21%)              |                               |                                         |
|                                                                              | 4-Agree(4)                               | 17 (9.7%)               | 81 (46%)              |                               |                                         |
|                                                                              | 5-Strongly agree(5)                      | 9 (5.1%)                | 48 (27.3%)            |                               |                                         |
|                                                                              | Mean                                     | 2.39                    | 3.29                  |                               |                                         |
|                                                                              | Likert scale score interpretation        | Disagree                | Neutral               |                               |                                         |
| Q2-Do your surgical wounds/scars limit the positions you can use during sex? | 1-Strongly disagree(1)                   | 33 (18.8%)              | 2 (1.1%)              | <b>&lt; 0.001<sup>a</sup></b> | Mean difference: –1.47 (–1.71 to –1.24) |
|                                                                              | 2-Disagree(2)                            | 80 (45.5%)              | 14 (8%)               |                               |                                         |
|                                                                              | 3-Neutral(3)                             | 37 (21%)                | 39 (22.2%)            |                               |                                         |
|                                                                              | 4-Agree(4)                               | 16 (9.1%)               | 70 (39.7%)            |                               |                                         |
|                                                                              | 5-Strongly agree(5)                      | 10 (5.7%)               | 51 (29%)              |                               |                                         |
|                                                                              | Mean                                     | 2.37                    | 3.87                  |                               |                                         |
|                                                                              | Likert scale score interpretation        | Disagree                | Agree                 |                               |                                         |
| Q3-Do you avoid sexual activity due to fear of pain or wound problems?       | 1-Strongly disagree(1)                   | 20 (11.4%)              | 0 (0.00%)             | <b>&lt; 0.001<sup>a</sup></b> | Mean difference: –1.41 (–1.65 to –1.18) |
|                                                                              | 2-Disagree(2)                            | 83 (47.2%)              | 24 (13.6%)            |                               |                                         |
|                                                                              | 3-Neutral(3)                             | 40 (22.7%)              | 19 (10.8%)            |                               |                                         |
|                                                                              | 4-Agree(4)                               | 25 (14.2%)              | 72 (40.9%)            |                               |                                         |
|                                                                              | 5-Strongly agree(5)                      | 8 (4.5%)                | 61 (34.7%)            |                               |                                         |

(Continues)

TABLE 3 | (Continued)

|                                                                                                                  |                                          | Karydakis<br>flap (176) | Limberg<br>flap (176) | p-value              | Effect size (95% CI)                       |
|------------------------------------------------------------------------------------------------------------------|------------------------------------------|-------------------------|-----------------------|----------------------|--------------------------------------------|
|                                                                                                                  | <b>Mean</b>                              | <b>2.53</b>             | <b>3.96</b>           |                      |                                            |
|                                                                                                                  | <b>Likert scale score interpretation</b> | <b>Disagree</b>         | <b>Agree</b>          |                      |                                            |
| Q4-Does friction, pressure, or body contact with the wound area affect your ability to continue sexual activity? | 1-Strongly disagree(1)                   | 31 (17.6%)              | 1 (0.6%)              | < 0.001 <sup>a</sup> | Mean difference:<br>-1.57 (-1.81 to -1.33) |
|                                                                                                                  | 2-Disagree(2)                            | 82 (46.6%)              | 10 (5.7%)             |                      |                                            |
|                                                                                                                  | 3-Neutral(3)                             | 30 (17%)                | 32 (18.2%)            |                      |                                            |
|                                                                                                                  | 4-Agree(4)                               | 21 (11.9%)              | 72 (40.9%)            |                      |                                            |
|                                                                                                                  | 5-Strongly agree(5)                      | 12 (6.8%)               | 61 (34.7%)            |                      |                                            |
|                                                                                                                  | <b>Mean</b>                              | <b>2.43</b>             | <b>4.03</b>           |                      |                                            |
|                                                                                                                  | <b>Likert scale score interpretation</b> | <b>Disagree</b>         | <b>Agree</b>          |                      |                                            |
| Q5-Do you use analgesics (painkillers) before or after sexual intercourse postoperatively?                       | 1-Strongly disagree(1)                   | 41 (23.3%)              | 2 (1.1%)              | < 0.001 <sup>a</sup> | Mean difference:<br>-1.71 (-1.95 to -1.46) |
|                                                                                                                  | 2-Disagree(2)                            | 78 (44.3%)              | 13 (7.4%)             |                      |                                            |
|                                                                                                                  | 3-Neutral(3)                             | 36 (20.5%)              | 34 (19.3%)            |                      |                                            |
|                                                                                                                  | 4-Agree(4)                               | 14 (8%)                 | 69 (39.2%)            |                      |                                            |
|                                                                                                                  | 5-Strongly agree(5)                      | 7 (4%)                  | 58 (33%)              |                      |                                            |
|                                                                                                                  | <b>Mean</b>                              | <b>2.25</b>             | <b>3.95</b>           |                      |                                            |
|                                                                                                                  | <b>Likert scale score interpretation</b> | <b>Disagree</b>         | <b>Agree</b>          |                      |                                            |
| Section C: Psychological and emotional impact                                                                    |                                          |                         |                       |                      |                                            |
| Q1-Does your body image or scar affect your sexual confidence or self-image during intimacy?                     | 1-Strongly disagree(1)                   | 40 (22.7%)              | 0 (0.00%)             | < 0.001 <sup>a</sup> | Mean difference:<br>-1.79 (-2.04 to -1.54) |
|                                                                                                                  | 2-Disagree(2)                            | 73 (41.5%)              | 8 (4.5%)              |                      |                                            |
|                                                                                                                  | 3-Neutral(3)                             | 30 (17%)                | 28 (15.9%)            |                      |                                            |
|                                                                                                                  | 4-Agree(4)                               | 26 (14.8%)              | 75 (42.6%)            |                      |                                            |
|                                                                                                                  | 5-Strongly agree(5)                      | 7 (4%)                  | 65 (36.9%)            |                      |                                            |
|                                                                                                                  | <b>Mean</b>                              | <b>2.35</b>             | <b>4.11</b>           |                      |                                            |
|                                                                                                                  | <b>Likert scale score interpretation</b> | <b>Disagree</b>         | <b>Agree</b>          |                      |                                            |
| Q2-Do you avoid sexual activity due to fear of embarrassment, pain, or poor body image?                          | 1-Strongly disagree(1)                   | 45 (25.6%)              | 4 (2.3%)              | < 0.001 <sup>a</sup> | Mean difference:<br>-1.54 (-1.78 to -1.30) |
|                                                                                                                  | 2-Disagree(2)                            | 78 (44.3%)              | 14 (8%)               |                      |                                            |
|                                                                                                                  | 3-Neutral(3)                             | 23 (13.1%)              | 34 (19.3%)            |                      |                                            |
|                                                                                                                  | 4-Agree(4)                               | 23 (13.1%)              | 70 (39.8%)            |                      |                                            |
|                                                                                                                  | 5-Strongly agree(5)                      | 7 (4%)                  | 54 (30.6%)            |                      |                                            |
|                                                                                                                  | <b>Mean</b>                              | <b>2.25</b>             | <b>3.88</b>           |                      |                                            |
|                                                                                                                  | <b>Likert scale score interpretation</b> | <b>Disagree</b>         | <b>Agree</b>          |                      |                                            |
| Q3-Has your overall sexual satisfaction decreased after surgery? Compared to before?                             | 1-Strongly disagree(1)                   | 50 (28.4%)              | 1 (0.6%)              | < 0.001 <sup>a</sup> | Mean difference:<br>-1.78 (-2.02 to -1.53) |
|                                                                                                                  | 2-Disagree(2)                            | 76 (34.2%)              | 13 (7.4%)             |                      |                                            |
|                                                                                                                  | 3-Neutral(3)                             | 29 (16.5%)              | 39 (22.2%)            |                      |                                            |
|                                                                                                                  | 4-Agree(4)                               | 14 (8%)                 | 65 (36.8%)            |                      |                                            |
|                                                                                                                  | 5-Strongly agree(5)                      | 7 (4%)                  | 58 (33%)              |                      |                                            |
|                                                                                                                  | <b>Mean</b>                              | <b>2.15</b>             | <b>3.94</b>           |                      |                                            |

(Continues)

TABLE 3 | (Continued)

|                                                                                                    |                                              | <b>Karydakis<br/>flap (176)</b> | <b>Limberg<br/>flap (176)</b> | <b>p-value</b>       | <b>Effect size (95% CI)</b>                   |
|----------------------------------------------------------------------------------------------------|----------------------------------------------|---------------------------------|-------------------------------|----------------------|-----------------------------------------------|
|                                                                                                    | <b>Likert scale score<br/>interpretation</b> | <b>Disagree</b>                 | <b>Agree</b>                  |                      |                                               |
| Section D: Functional and partner-related issues                                                   |                                              |                                 |                               |                      |                                               |
| Q1-Do you have difficulty becoming aroused or maintaining arousal?                                 | 1-Strongly disagree(1)                       | 48 (27.3%)                      | 16 (9.1%)                     | < 0.001 <sup>a</sup> | Mean difference:<br>−1.42 (−1.66<br>to −1.19) |
|                                                                                                    | 2-Disagree(2)                                | 74 (42%)                        | 0 (0.00%)                     |                      |                                               |
|                                                                                                    | 3-Neutral(3)                                 | 31 (17.6%)                      | 34 (19.3%)                    |                      |                                               |
|                                                                                                    | 4-Agree(4)                                   | 10 (5.7%)                       | 65 (36.9%)                    |                      |                                               |
|                                                                                                    | 5-Strongly agree(5)                          | 13 (7.4%)                       | 61 (34.7%)                    |                      |                                               |
|                                                                                                    | <b>Mean</b>                                  | <b>2.23</b>                     | <b>3.88</b>                   |                      |                                               |
|                                                                                                    | <b>Likert scale score<br/>interpretation</b> | <b>Disagree</b>                 | <b>Agree</b>                  |                      |                                               |
| Q2-Has your partner noticed changes in my comfort or behavior during sexual activity after surgery | 1-Strongly disagree(1)                       | 45 (25.6%)                      | 15 (8.5%)                     | < 0.001 <sup>a</sup> | Mean difference:<br>−1.53 (−1.77<br>to −1.29) |
|                                                                                                    | 2-Disagree(2)                                | 82 (46.6%)                      | 0 (0.00%)                     |                      |                                               |
|                                                                                                    | 3-Neutral(3)                                 | 23 (13.1%)                      | 34 (19.3%)                    |                      |                                               |
|                                                                                                    | 4-Agree(4)                                   | 20 (11.4%)                      | 68 (38.7%)                    |                      |                                               |
|                                                                                                    | 5-Strongly agree(5)                          | 6 (3.4%)                        | 59 (33.5%)                    |                      |                                               |
|                                                                                                    | <b>Mean</b>                                  | <b>2.20</b>                     | <b>3.88</b>                   |                      |                                               |
|                                                                                                    | <b>Likert scale score<br/>interpretation</b> | <b>Disagree</b>                 | <b>Agree</b>                  |                      |                                               |

Note: Effect sizes are reported as mean difference or OR with 95% confidence intervals. Likert scale interpretation: 1.00–1.79 = Strongly disagree; 1.80–2.59 = Disagree; 2.60–3.39 = Neutral; 3.40–4.19 = Agree; 4.20–5.00 = Strongly agree. For all items, a higher score indicates a worse outcome (more pain, greater limitation, more avoidance, or lower satisfaction). The bold values represent statistically significant.

<sup>a</sup>Statistically significant.

findings indicate that surgical technique had a strong independent effect on functional recovery.

#### 4 | Discussion

In this FLARE study, we compared two widely used surgical techniques for PSD—KF and LF—with a focus on functional outcomes that are especially relevant to young, active patients, namely the ability to resume sexual activity and driving. These aspects of recovery are often overlooked, and our study may add to the literature by directly comparing them. Therefore, we believe our study may provide preliminary, clinically relevant insights into postoperative functional recovery in young, active patients with PSD. Overall, although both procedures achieved comparable wound-healing outcomes, patients in the KF group reported a significantly faster return to driving and sexual function. While our study was not designed to determine causal mechanisms, several factors may help explain the observed differences in recovery. From a physiological standpoint, the more extensive tissue mobilization involved in the LF could potentially increase the likelihood of irritation or injury to sacral and perineal sensory nerves. This might contribute to postoperative pain or altered sensation, both of which can affect comfort when sitting, an essential component of driving and sexual activity. In addition, the resulting scar in LF may be less flexible, potentially restricting movement and causing discomfort during activities that place

pressure on the surgical area or require hip flexion [42–44]. Beyond these physical factors, psychological aspects may also play an important role. Scar appearance can influence body image and self-confidence, which in turn may affect sexual well-being and the willingness to resume intimate activity [45]. However, these explanations are hypothetical and require confirmation in future studies incorporating objective assessments, including sensory testing, scar biomechanical evaluation, and body image perception. It is also important to acknowledge that baseline differences between groups, particularly in disease severity, may have influenced the results. Patients undergoing LF may have had more advanced or complex disease, which could partly explain the slower recovery. However, even after adjustment using multivariable analysis, the association between KF and faster functional recovery remained significant.

Our findings are consistent with previous studies reporting that the KF is associated with less postoperative pain, fewer functional limitations, and a quicker return to daily activities compared to the LF. However, prior research has largely focused on traditional outcomes such as wound complications and recurrence. In contrast, our study extends this evidence by demonstrating meaningful differences in sexual and driving function [20, 46]. In alignment with our results, Guner et al. [47] reported that the LF, despite its efficacy in wound healing, is associated with a higher incidence of pain and functional limitations. Our findings build

**TABLE 4** | Driving ability in studied groups (secondary outcome).

|                                                                                         |                                   | Karydakis<br>flap (176) | Limberg<br>flap (176) | p-value              | Effect size (95% CI)                       |
|-----------------------------------------------------------------------------------------|-----------------------------------|-------------------------|-----------------------|----------------------|--------------------------------------------|
| Section A: Return to Driving                                                            |                                   |                         |                       |                      |                                            |
| Q1-When did you resume driving after surgery? (days)                                    |                                   | 9 (5–11)                | 19 (16–22)            | < 0.001 <sup>a</sup> | <i>r</i> = 0.7                             |
| Q2-How long can you sit while driving (or sitting in a car) before feeling discomfort?  | < 15 min                          | 20 (11.4%)              | 66 (37.5%)            | < 0.001 <sup>a</sup> | OR 0.3, 95% CI 0.2–0.4                     |
|                                                                                         | 15–30 min                         | 5 (2.8%)                | 73 (41.5%)            |                      |                                            |
|                                                                                         | 30–60                             | 21 (11.9%)              | 15 (8.5%)             |                      |                                            |
|                                                                                         | > 1 h                             | 78 (44.3%)              | 16 (9.1%)             |                      |                                            |
|                                                                                         | No discomfort                     | 52 (29.5%)              | 6 (3.4%)              |                      |                                            |
| Section B: Pain and sitting tolerance                                                   |                                   |                         |                       |                      |                                            |
| Q1-Do you feel pain when sitting in a driving position?                                 | 1-Strongly disagree(1)            | 66 (37.5%)              | 11 (6.3%)             | < 0.001 <sup>a</sup> | Mean difference: –1.94<br>(–2.19 to –1.68) |
|                                                                                         | 2-Disagree(2)                     | 64 (36.4%)              | 0 (0.00%)             |                      |                                            |
|                                                                                         | 3-Neutral(3)                      | 26 (14.8%)              | 34 (19.3%)            |                      |                                            |
|                                                                                         | 4-Agree(4)                        | 20 (11.4%)              | 63 (35.8%)            |                      |                                            |
|                                                                                         | 5-Strongly agree(5)               | 0 (0.00%)               | 68 (38.6%)            |                      |                                            |
|                                                                                         | Mean                              | 2                       | 4                     |                      |                                            |
|                                                                                         | Likert scale score interpretation | Disagree                | Agree                 |                      |                                            |
| Q2-What is your pain score while sitting in the driver's seat (0–10 VAS)? (median, IQR) |                                   | 2 (1–3)                 | 4 (4–5)               | < 0.001 <sup>a</sup> | <i>r</i> = 0.5                             |
| Q3-Do you need a pillow or cushion to tolerate driving?                                 | 1-Strongly disagree(1)            | 50 (28.4%)              | 13 (7.4%)             | < 0.001 <sup>a</sup> | Mean difference: –1.53<br>(–1.77 to –1.29) |
|                                                                                         | 2-Disagree(2)                     | 74 (42%)                | 0 (0.00%)             |                      |                                            |
|                                                                                         | 3-Neutral(3)                      | 31 (17.6%)              | 37 (21%)              |                      |                                            |
|                                                                                         | 4-Agree(4)                        | 10 (5.7)                | 72 (40.9%)            |                      |                                            |
|                                                                                         | 5-Strongly agree(5)               | 11 (6.3%)               | 54 (30.7%)            |                      |                                            |
|                                                                                         | Mean                              | 2.19                    | 3.87                  |                      |                                            |
|                                                                                         | Likert scale score interpretation | Disagree                | Agree                 |                      |                                            |
| Q4-Are you able to wear a seatbelt or sit upright comfortably?                          | 1-Strongly disagree(1)            | 13 (7.4%)               | 52 (29.5%)            | < 0.001 <sup>a</sup> | Mean difference: –1.51<br>(–1.75 to –1.27) |
|                                                                                         | 2-Disagree(2)                     | 0 (0.00%)               | 70 (39.8%)            |                      |                                            |
|                                                                                         | 3-Neutral(3)                      | 38 (21.5%)              | 35 (19.9%)            |                      |                                            |
|                                                                                         | 4-Agree(4)                        | 67 (38.1%)              | 5 (2.8%)              |                      |                                            |
|                                                                                         | 5-Strongly agree(5)               | 58 (33%)                | 14 (8%)               |                      |                                            |
|                                                                                         | Mean                              | 2.19                    | 3.89                  |                      |                                            |
|                                                                                         | Likert scale score interpretation | Disagree                | Agree                 |                      |                                            |
| Q5-Do you need analgesics before/after driving?                                         | 1-Strongly disagree(1)            | 60 (34.1%)              | 18 (10.2%)            | < 0.001 <sup>a</sup> | Mean difference: –1.6<br>(–1.84 to –1.36)  |
|                                                                                         | 2-Disagree(2)                     | 70 (39.8%)              | 0 (0.00%)             |                      |                                            |
|                                                                                         | 3-Neutral(3)                      | 34 (19.3%)              | 33 (18.8%)            |                      |                                            |
|                                                                                         | 4-Agree(4)                        | 2 (1.1%)                | 64 (36.4%)            |                      |                                            |
|                                                                                         | 5-Strongly agree(5)               | 10 (5.7%)               | 61 (34.7%)            |                      |                                            |
|                                                                                         | Mean                              | 2.04                    | 3.85                  |                      |                                            |
|                                                                                         | Likert scale score interpretation | Disagree                | Agree                 |                      |                                            |
| Section C: Confidence and recovery                                                      |                                   |                         |                       |                      |                                            |
| Q1-Did you resume driving later than expected due to discomfort?                        | 1-Strongly disagree(1)            | 54 (30.7%)              | 12 (6.8%)             | < 0.001 <sup>a</sup> | Mean difference: –1.5<br>(–1.73 to –1.26)  |
|                                                                                         | 2-Disagree(2)                     | 63 (35.8%)              | 0 (0.00%)             |                      |                                            |
|                                                                                         | 3-Neutral(3)                      | 39 (22.2%)              | 34 (19.3%)            |                      |                                            |
|                                                                                         | 4-Agree(4)                        | 3 (1.7%)                | 71 (40.3%)            |                      |                                            |
|                                                                                         | 5-Strongly agree(5)               | 17(9.7%)                | 59 (33.6%)            |                      |                                            |
|                                                                                         | Mean                              | 2.23                    | 3.93                  |                      |                                            |
|                                                                                         | Likert scale score interpretation | Disagree                | Agree                 |                      |                                            |
| Q2-Are you not confident while driving after surgery?                                   | 1-Strongly disagree(1)            | 66 (37.5%)              | 6 (3.4%)              | < 0.001 <sup>a</sup> | Mean difference: –1.49<br>(–1.73 to –1.26) |

(Continues)

TABLE 4 | (Continued)

|                                                                          |                                          | Karydakias<br>flap (176) | Limberg<br>flap (176) | p-value              | Effect size (95% CI)                       |
|--------------------------------------------------------------------------|------------------------------------------|--------------------------|-----------------------|----------------------|--------------------------------------------|
|                                                                          | 2-Disagree(2)                            | 41 (23.3%)               | 0 (0.00%)             |                      |                                            |
|                                                                          | 3-Neutral(3)                             | 46 (26.1%)               | 51 (29%)              |                      |                                            |
|                                                                          | 4-Agree(4)                               | 6 (3.4%)                 | 64 (36.4%)            |                      |                                            |
|                                                                          | 5-Strongly agree(5)                      | 17 (9.7%)                | 55 (31.3%)            |                      |                                            |
|                                                                          | <b>Mean</b>                              | <b>2.24</b>              | <b>3.92</b>           |                      |                                            |
|                                                                          | <b>Likert scale score interpretation</b> | <b>Disagree</b>          | <b>Agree</b>          |                      |                                            |
| Q3-Are you worried that driving may reopen or stress my surgical wound?  | 1-Strongly disagree(1)                   | 58 (33%)                 | 13 (7.4%)             | < 0.001 <sup>a</sup> | Mean difference: -1.62<br>(-1.86 to -1.38) |
|                                                                          | 2-Disagree(2)                            | 65 (36.9%)               | 0 (0.00%)             |                      |                                            |
|                                                                          | 3-Neutral(3)                             | 38 (21.6%)               | 39 (22.2%)            |                      |                                            |
|                                                                          | 4-Agree(4)                               | 5 (2.8%)                 | 68 (38.6%)            |                      |                                            |
|                                                                          | 5-Strongly agree(5)                      | 10 (5.7%)                | 56 (31.8%)            |                      |                                            |
|                                                                          | <b>Mean</b>                              | <b>2.11</b>              | <b>3.87</b>           |                      |                                            |
|                                                                          | <b>Likert scale score interpretation</b> | <b>Disagree</b>          | <b>Agree</b>          |                      |                                            |
| Section D: Daily life impact                                             |                                          |                          |                       |                      |                                            |
| Q1-Have driving limitations affected your return to work or social life? | 1-Strongly disagree(1)                   | 62 (35.2%)               | 24 (13.6%)            | < 0.001 <sup>a</sup> | Mean difference: -1.32<br>(-1.55 to -1.09) |
|                                                                          | 2-Disagree(2)                            | 62 (35.2%)               | 0 (0.00%)             |                      |                                            |
|                                                                          | 3-Neutral(3)                             | 29 (16.5%)               | 30 (17%)              |                      |                                            |
|                                                                          | 4-Agree(4)                               | 13 (7.4%)                | 63 (35.9%)            |                      |                                            |
|                                                                          | 5-Strongly agree(5)                      | 10 (5.7%)                | 59 (33.5%)            |                      |                                            |
|                                                                          | <b>Mean</b>                              | <b>2.13</b>              | <b>3.75</b>           |                      |                                            |
|                                                                          | <b>Likert scale score interpretation</b> | <b>Disagree</b>          | <b>Agree</b>          |                      |                                            |
| Q2-Do you feel limited in how far or how long you can drive?             | 1-Strongly disagree(1)                   | 61 (34.7%)               | 33 (18.7%)            | < 0.001 <sup>a</sup> | Mean difference: -1.22<br>(-1.44 to -0.99) |
|                                                                          | 2-Disagree(2)                            | 64 (36.4%)               | 0 (0.00%)             |                      |                                            |
|                                                                          | 3-Neutral(3)                             | 31 (17.6%)               | 22 (12.5%)            |                      |                                            |
|                                                                          | 4-Agree(4)                               | 12 (6.8%)                | 60 (34.1%)            |                      |                                            |
|                                                                          | 5-Strongly agree(5)                      | 8 (4.5%)                 | 61 (34.7%)            |                      |                                            |
|                                                                          | <b>Mean</b>                              | <b>2.10</b>              | <b>3.65</b>           |                      |                                            |
|                                                                          | <b>Likert scale score interpretation</b> | <b>Disagree</b>          | <b>Agree</b>          |                      |                                            |

Note: Effect sizes are reported as mean difference, *r* value (0.1 = small effect size, 0.3 = moderate effect size, and 0.5 = large effect size), or OR with 95% confidence intervals. Likert scale interpretation: 1.00–1.79 = Strongly disagree; 1.80–2.59 = Disagree; 2.60–3.39 = Neutral; 3.40–4.19 = Agree; 4.20–5.00 = Strongly agree. For all items, a higher score indicates a worse outcome (more pain, greater limitation, more avoidance, or lower satisfaction). The bold values represent statistically significant.

<sup>a</sup>Statistically significant.

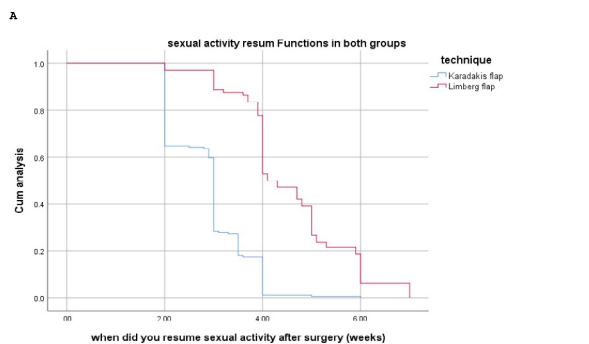
upon this by quantifying a significant inverse impact on sexual and driving capabilities, outcomes not evaluated by Guner et al.

Further contextualizing our work, a study by Erkent et al. [37] also prioritized functional recovery after PSD surgery and compared KF and LF. A key distinction in methodology is that while our investigation focused exclusively on these two flap techniques, Erkent et al. included primary midline closure as a third comparative arm. Our results showed that the KF group resumed sexual activity and driving earlier than the LF group. Patients in the KF also reported fewer activity restrictions and greater confidence, with less interference in the occupational and social domains. Consistent with these results, Erkent et al. found that both flap techniques achieved faster recovery milestones than primary midline closure, including pain-free walking, pain-free sitting, and return to work. Although KF allowed a marginally quicker return to normal activity than LF, the difference was not statistically significant. Similarly, Erkent et al. reported improved QOL and patient satisfaction with both flap procedures, with

marginally higher satisfaction in the KF; this difference was not statistically significant.

The rapid functional recovery of the KF may be attributable to its inherent design. Off-midline closure using the KF places the suture line away from the high-tension, high-moisture midline cleft. This may reduce the direct pressure on the wound while sitting, and likely minimizes tension during sexual activity or driving. Although the KF and LF tried to flatten the natal cleft, the KF achieves a more natural flattening or contouring with less tension laterally compared to the rotational nature and potentially larger defect coverage of LF. KF involves simpler advancement and less tissue handling than the rotation and mobilization required for LF. Less extensive tissue dissection and mobilization lead to less postoperative pain and edema.

The observed differences in sexual and driving-related outcomes were statistically significant. With respect to clinical significance, patients undergoing the KF resumed sexual activity 1.7 weeks



Overall Comparisons

|                                | Chi-Square | df | Sig.   |
|--------------------------------|------------|----|--------|
| Log Rank (Mantel-Cox)          | 14,228     | 1  | <0,001 |
| Breslow (Generalized Wilcoxon) | 15,597     | 1  | <0,001 |
| Tarone-Ware                    | 15,728     | 1  | <0,001 |

Test of equality of survival distributions for the different levels of technique.



Cox regression for sexual function

Overall Comparisons

|                                | Chi-Square | df | Sig.   |
|--------------------------------|------------|----|--------|
| Log Rank (Mantel-Cox)          | 17,922     | 1  | <0,001 |
| Breslow (Generalized Wilcoxon) | 37,180     | 1  | <0,001 |
| Tarone-Ware                    | 32,162     | 1  | <0,001 |

Test of equality of survival distributions for the different levels of technique.

Omnibus Tests of Model Coefficients<sup>a</sup>

| Omnibus Tests of Model Coefficients |                 |    |        |                           |    |        |                            |    |        |
|-------------------------------------|-----------------|----|--------|---------------------------|----|--------|----------------------------|----|--------|
| -2 Log Likelihood                   | Overall (score) |    |        | Change From Previous Step |    |        | Change From Previous Block |    |        |
|                                     | Chi-square      | df | Sig.   | Chi-square                | df | Sig.   | Chi-square                 | df | Sig.   |
| 1182,988                            | 12,913          | 1  | <0.001 | 11,705                    | 1  | <0.001 | 11,705                     | 1  | <0.001 |

a. Beginning Block Number 1, Method = Enter

Variables in the Equation

|           | B    | SE   | Wald   | df | Sig.   | Exp(B) | 95.0% CI for Exp(B) |
|-----------|------|------|--------|----|--------|--------|---------------------|
|           |      |      |        |    |        | Lower  | Upper               |
| technique | ,814 | ,230 | 12,476 | 1  | <0,001 | 2,257  | 1,437 3,546         |

Cox regression for driving function

Omnibus Tests of Model Coefficients<sup>a</sup>

| Omnibus Tests of Model Coefficients |                 |    |       |                           |    |       |                            |    |       |
|-------------------------------------|-----------------|----|-------|---------------------------|----|-------|----------------------------|----|-------|
| -2 Log Likelihood                   | Overall (score) |    |       | Change From Previous Step |    |       | Change From Previous Block |    |       |
|                                     | Chi-square      | df | Sig.  | Chi-square                | df | Sig.  | Chi-square                 | df | Sig.  |
| 1250.219                            | 17.073          | 1  | <.001 | 15.314                    | 1  | <.001 | 15.314                     | 1  | <.001 |

a. Beginning Block Number 1, Method = Enter

Variables in the Equation

|           | B    | SE   | Wald   | df | Sig.   | Exp(B) | 95.0% CI for Exp(B) |
|-----------|------|------|--------|----|--------|--------|---------------------|
|           |      |      |        |    |        | Lower  | Upper               |
| technique | ,861 | ,212 | 16,455 | 1  | <0,001 | 2,366  | 1,561 3,588         |

**FIGURE 2** | Figure 2 Presents Kaplan–Meier survival analysis curves comparing the time to resumption of (A) sexual activity and (B) driving ability between patients undergoing KF and those receiving LF for PSD surgery. Overall comparisons were done using log rank (mantel-cox), breslow (generalized wilcoxon) and tarone-ware. cox regression tables for sexual function and driving ability were added.

earlier and driving 10 days earlier than LF patients—differences that are likely perceptible to patients. However, we acknowledge that small numerical differences in patient-reported outcomes may not always translate into meaningful functional improvement for every individual, and the clinical significance should be interpreted cautiously. It is noteworthy that while the difference in hospitalization duration reached statistical significance ( $p = 0.03$ ), the identical medians (3 days in both groups) and the small difference in interquartile ranges (2–4 vs. 3–4) suggest limited clinical significance. The observed difference indicates that some patients with KF were discharged on postoperative day 2, whereas none were. Whether this reflects true accelerated recovery or differences in institutional discharge protocols (e.g., surgeon preference, patient social support, or regional practice variation) cannot be determined from this retrospective analysis. Future prospective studies with standardized discharge criteria are needed to confirm whether KF confers a meaningful reduction in hospital stay.

## 4.1 | Clinical Relevance

While functional recovery differences appear clinically meaningful, the retrospective design and potential for residual confounding preclude definitive conclusions about causation. These findings should be considered hypothesis-generating rather than practice-changing. An earlier return to sexual activity in KF may influence quality of life, relationship dynamics, and psychological well-being. In this young population, scar perception and body image are important; a less conspicuous off-midline scar with KF may reduce avoidance of intimacy. Similarly, earlier return to driving in the KF group may have practical implications, enabling faster resumption of daily activities, independence, and work. In contrast, delayed driving recovery after LF may contribute to temporary functional limitation and reliance on others.

## 4.2 | Strengths and Limitations

This study has several strengths, such as its focus on driving and sexual activity, which are important for the QOL of the mostly young PSD population, and its goal of filling a major gap in PSD surgery. Moreover, this study included an adequate cohort of patients adhering to predefined perioperative protocols. The retrospective design, however, inherently carries the risk of selection bias. Although patients were enrolled consecutively, the choice of surgical technique was not randomized and depended on surgeon preference and anatomical factors, introducing potential selection bias. Despite adjustment for measured confounders, residual confounding from unmeasured variables may persist. Conducting the study across high-volume tertiary centers may enhance generalizability, but it does not eliminate this limitation. Functional outcomes were assessed using structured Likert-scale questionnaires; however, these remain subjective and may be influenced by individual, cultural, and psychosocial factors. In addition, the questionnaires were not disease-specific, and formal cross-cultural evaluation was not conducted. However, the questionnaires demonstrated acceptable internal consistency (Cronbach's  $\alpha = 0.84$  and  $0.81$ ). Future prospective studies using structured quality-of-life instruments

are warranted. The similar recurrence rates at 1 year should be interpreted cautiously, as lack of statistical significance does not imply equivalence, and recurrence in PSD may occur beyond the first postoperative year. Longer follow-up is needed to assess true long-term outcomes [16, 25, 48]. Recall bias may have affected patient-reported outcomes, particularly regarding recovery timing. The large number of comparisons increases the risk of type I error; therefore, only prespecified primary and key secondary outcomes were formally analyzed, while other findings are considered exploratory. Additionally, no formal sample size calculation was performed, and the study may be underpowered. Accordingly, these results should be viewed as hypothesis-generating and require confirmation in well-designed prospective studies.

## 5 | Conclusion

In this multicenter retrospective cohort study, the KF may be associated with a faster return to sexual activity and driving than the LF, despite similar 1-year recurrence rates. These differences may be clinically meaningful, with earlier recovery, better sitting tolerance, and lower pain scores in the KF group. However, given the retrospective design and potential residual confounding, these findings should be interpreted as associations rather than definitive evidence of superiority. Patient-centered functional outcomes, such as return to daily activities, should be considered in surgical decision-making for PSD, particularly in young, active patients. Future prospective studies using structured quality-of-life instruments are warranted.

### Author Contributions

**Tamer A. A. M. Habeeb:** conceptualization, writing – original draft, visualization, methodology, writing – review and editing, project administration. **Abdulzahra Hussain:** funding acquisition, writing – original draft, project administration, methodology, writing – review and editing, resources. **Jose Bueno-Lledó:** funding acquisition, software, validation, resources. **Mariano Eduardo Gimenez:** conceptualization, writing – original draft, formal analysis, project administration, validation. **Alberto Aiolfi:** conceptualization, funding acquisition, formal analysis, software, supervision, methodology. **Ahmed Abdelsamad:** methodology, software, supervision, writing – review and editing, writing – original draft. **Massimo Chiaretti:** funding acquisition, writing – original draft, validation, project administration, data curation, supervision, writing – review and editing. **Igor A. Kryvoruchko:** writing – original draft, methodology, supervision. **Mallikarjuna N. Manangi:** investigation, funding acquisition, formal analysis, methodology. **Nasreldin Mohammed Algalaly:** methodology, funding acquisition, project administration, data curation, supervision. **Mohammed Abbas:** conceptualization, funding acquisition, validation, formal analysis, data curation. **Mohamed Fathy Labib:** conceptualization, validation, visualization, supervision, data curation. **Osama Almezaien:** conceptualization, funding acquisition, visualization, software, resources. **Mohamed Hassan Mohamed Elkaseer:** investigation, conceptualization, methodology, formal analysis, resources. **Hamada Rashad Mohamed Abdelkader:** investigation, validation, writing – review and editing, formal analysis. **Mohamed Swelam:** conceptualization, methodology, funding acquisition, data curation. **Mahmoud E. Nagaty:** conceptualization, investigation, funding acquisition, formal analysis, supervision. **Mahmoud Abd Alhady Abd Alaziz Abd Alhady:** funding acquisition, writing – review and editing, validation, software, supervision.

**Mohamed Ibrahim Henish:** funding acquisition, validation, writing – review and editing, data curation, supervision. **Hamdy Farag:** resources, software, funding acquisition, investigation, conceptualization. **Mohamed Ibrahim Shalamesh:** conceptualization, resources, data curation, project administration, methodology, funding acquisition. **Ibtsam AbdElMaksoud Mohamed El Shamy:** funding acquisition, project administration, software, resources. **Alaa A. Fiad:** funding acquisition, visualization, supervision, writing – review and editing. **Hamdi Elbelkasi:** investigation, funding acquisition, data curation, supervision, validation, methodology. **Mohamed Ibrahim Abo Alsaad:** conceptualization, writing – review and editing, software, data curation, supervision. **Mahmoud Moustafa AL-Shareef:** conceptualization, visualization, methodology, formal analysis. **Mahmoud Abdelnasser Eissa:** writing – original draft, funding acquisition, visualization, formal analysis. **Mahmoud Elghonimy Abd Elsadek:** conceptualization, software, supervision, validation, writing – review and editing, writing – original draft. **Abouelatta K. H. Ali:** funding acquisition, writing – review and editing, visualization, formal analysis. **Maged Z. Youssef:** validation, writing – review and editing, formal analysis, data curation, project administration. **Mohamed Abdelbar Mohamed:** conceptualization, funding acquisition, methodology, software. **Ahmed Hamdy:** visualization, methodology, writing – review and editing, formal analysis, data curation. **Ali Hussein Khedr:** conceptualization, validation, software, supervision, data curation. **Ayman A. Khater:** conceptualization, writing – review and editing, methodology, supervision. **Hazem E. Ali:** conceptualization, funding acquisition, writing – original draft, writing – review and editing, software, resources. **Mohammed Siam:** visualization, conceptualization, project administration, data curation, writing – original draft. **Mohamad Naem Elnahas:** funding acquisition, writing – original draft, visualization, methodology, resources, supervision. **Mohamed Adel Saqr:** conceptualization, validation, writing – review and editing, supervision, data curation, project administration. **Mostafa Fathy Ibrahim Ahmed:** conceptualization, validation, project administration, supervision. **Mohamed Mahmoud Mokhtar Mohamed:** conceptualization, writing – review and editing, writing – original draft, formal analysis, resources. **Mohamed Elnemr:** funding acquisition, validation, writing – review and editing, writing – original draft, software, supervision. **Bassam Mousa:** conceptualization, funding acquisition, writing – original draft, visualization, methodology, software, project administration, supervision. **Tamer Wasefy:** conceptualization, funding acquisition, formal analysis, writing – original draft, resources. **Ahmed M. El Teliti:** conceptualization, funding acquisition, writing – original draft, writing – review and editing, supervision. **Mohamed Abozaid:** conceptualization, writing – original draft, visualization, writing – review and editing, project administration, supervision. **Adel Morsi:** funding acquisition, resources, data curation, writing – review and editing. **Taha A. Biomy:** conceptualization, investigation, writing – review and editing, writing – original draft, data curation, resources. **Baher Atef:** methodology, writing – original draft, project administration, resources. **Mohamed Mahmoud Almeniaawy:** investigation, writing – review and editing, formal analysis, software, resources. **Mohamad S. Moussa:** validation, formal analysis, resources, data curation, writing – original draft. **Mohamed H. Hebeishy:** investigation, writing – original draft, methodology, project administration, data curation, resources. **Hasnaa Metwally:** validation, visualization, writing – review and editing, writing – original draft, supervision. **Mohamed S. Bayomi:** investigation, funding acquisition, project administration, data curation. **Abdelshafy Mostafa:** conceptualization, funding acquisition, writing – original draft, writing – review and editing, formal analysis, supervision. **Ahmed Attia Saleh:** conceptualization, funding acquisition, writing – original draft, writing – review and editing, supervision. **Mahmoud Abdou Yassin:** visualization, formal analysis, project administration, data curation, resources.

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## Ethics Statement

All authors comply with ethical requirements.

## Consent

Informed consent was obtained from all individual participants included in the study.

## Conflicts of Interest

The authors declare no conflicts of interest.

## Data Availability Statement

Will be provided by the corresponding author upon reasonable request.

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## Supporting Information

Additional supporting information can be found online in the Supporting Information section.

**Table S1:** Postoperative sexual function questionnaire. **Table S2:** Univariate and multivariate logistic regression analyses to predict delayed full return to sexual activity and delayed return to full driving ability of > 4 weeks following operation.