

Case report

New Keystone flap application in vulvo-perineal reconstructive surgery: A case series

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ABSTRACT

Objective: This study aimed to evaluate the application of the Keystone flap technique and the long-term results of vulvovaginal reconstruction after vulvar surgery.

Methods: This is the first case series describing the application of the Keystone perforator island flaps (KPIF) technique to close a wide defect after radical vulvectomy. We prospectively collected patient demographics, operative times, complications, pathologic results, and length of stay on all patients. The benefits, cosmetic results and satisfaction of patients were analyzed in the follow up.

Results: Five patients were selected for the study: four underwent radical vulvectomy for squamous cell vulvar cancer, and one underwent vulvar wide excision for Paget disease followed by reconstruction with the Keystone flap technique. The defects were successfully covered by the Keystone flap technique in all patients.

Conclusions: Keystone flaps seem to be easy to design and elevate, and it offers rapid fasciocutaneous closure in wide vulvo-perineal defects with excellent long-term results.

1. Introduction

The surgical treatments used for vulvar cancer have undergone continuous changes over the past years. Radical surgical approaches, such as block resection, have been gradually replaced in favor of surgical approaches that require dissection of less tissue to reduce post-operative morbidity and reduce vulvar deformity (de Hullu et al., 2006).

Complications such as dehiscence, infections and necrosis are common after primary closure carried out following radical vulvectomy, with an increase in the hospitalization time, costs, morbidity and delay of possible adjuvant therapy (Tan et al., 2014). Therefore, primary closure to the lesion is possible in the case of a small loss of tissue. However, in the case of total or partial resection with a significant loss of substance, the use of flaps should be required.

Various local flaps have been described for vulvar reconstructive surgery, such as the pudendal thigh flap, Singapore flap, lotus leaf flap and gluteal fold flap (Di Donato et al., 2017). These flaps require specific individualization of the perforators of the internal pudendal artery during flap planning or intraoperatively.

The Keystone design perforator island flap (KPIF), developed by

Felix Behan in 1995, is a technique widely used in numerous body regions to reconstruct defects after excision of skin cancer. The main advantage of this technique is the safe capture of the required perforator base without requiring the identification of specific perforators intraoperatively (Behan, 2003).

We propose the Keystone flap as a new, innovative and useful solution to cover the extensive skin defect remaining after a wide vulvar excision for oncological indications.

2. Methods

2.1. Study design

This is a prospective study evaluating specific measures that relate to cosmetic results for scars using the Keystone technique in vulvar reconstruction.

After obtaining institutional review board (IRB) approval, all the study participants or their legal guardians provided informed written consent about personal and medical data collection.

All the patients who had undergone radical vulvectomy or wide vulvar excision between December 2016 and July 2018 at the Division

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of Obstetrics and Gynecology, University of Cagliari were enrolled in the study. The team approach comprised both a gynecologic oncologist and a plastic surgeon in all procedures. All the patients signed an approved informed consent.

The clinical patient characteristics included were age, body mass index (BMI), parity, associated pathologies, and clinical tumor stage (according to FIGO classification) and grade.

Intraoperative parameter evaluation included the operative time, blood loss, length of hospitalization, early complications defined within 30 days, and late complications after 30 days. Moreover, we recorded postoperative complications such as wound infections, vulvar breakdown, and partial or total flap necrosis.

3. Surgical technique

The KPIF is a curvilinear-shaped, trapezoidal design flap, which essentially comprises two conjoined V-Y flaps in opposing directions. The surgical wound is measured in two sizes perpendicular to the defect, with a width at least equal to the width of the defect, and the length of each lateral limb at least equal to half the length of the defect. The reconstruction must be elliptic, with the axis parallel to the skin nerves, veins, arteries and perineum. The long axis is chosen to orient the defect and the tension lines. The flap is islanded (Fig. 1) to enhance perforator hemodynamics and facilitate mobilization and is inset with primary closure or V-Y closure of the peripheries of the donor site. The perineal KPIF, while utilizing the same perforator base as other internal pudendal artery perforator flaps, can be designed in an infinite range of patterns based on the defect requiring reconstruction. The width of the shaped unilateral trapezoidal flap should be sufficient to cover the defect extensively; approximation of the subcutaneous layer is performed using single stitches with 3/0 Monocryl and running a subcuticular suture with 4/0 Monocryl.

4. Results

Between December 2016 and July 2018, 5 patients underwent vulvar surgery with large tissue losses: four of these patients underwent radical vulvectomy for squamous cell carcinoma (SCC), and one

required distal urethrectomy for urethral involvement. One patient underwent a wide vulvar excision for Paget disease. The Keystone technique was proposed preoperatively for vulvar reconstruction.

The median age was 69 years (range, 66–82 years), and the median BMI was 29.9 kg/m² (range, 22.1–38.5 kg/m²). All the patients had preoperative comorbidities: four patients were on antihypertensive treatment, one patient had type 2 diabetes, and one patient had previously undergone brachytherapy for cervical cancer (Table 1).

Four patients with SCC underwent bilateral inguino-femoral lymphadenectomy on the same day of radical vulvectomy. Tumor staging was assessed by FIGO classification: 2 patients had stage I b disease, and 2 patients had stage III because of lymph node involvement. All SCC groups had tumor-free excision margins. The patient with Paget disease presented positive margins.

The median operation time (skin-to-skin) was 313 min (range, 95–470 min). The median blood loss was 200 mL (range, 50–500 mL); no patient required intraoperative blood transfusion, and one patient needed postoperative blood transfusion. The median length of hospital stay was 8 days (range, 4–10 days; Table 1).

There were no major intraoperative complications, and the defects were successfully covered by the Keystone flap technique in all patients.

Early postoperative complications occurred in 1 patient, who was affected by diabetes mellitus and had partial wound dehiscence requiring readmittance on postoperative day 21. Surgical revision was required. The same patient showed complete urinary incontinence as a major late postoperative complication. No skin flap necrosis was observed.

After 6 months, one patient with a previous history of cervical cancer had local vaginal recurrence and she underwent brachytherapy with a complete response. Another patient, after 16 months, presented urethral local recurrence and she underwent surgical excision. At this moment, all the patients are free of disease (Table 2).

The long-term results were functionally and cosmetically acceptable, and the patients were satisfied.

5. Discussion

Several reconstructive techniques have been described for vulvar

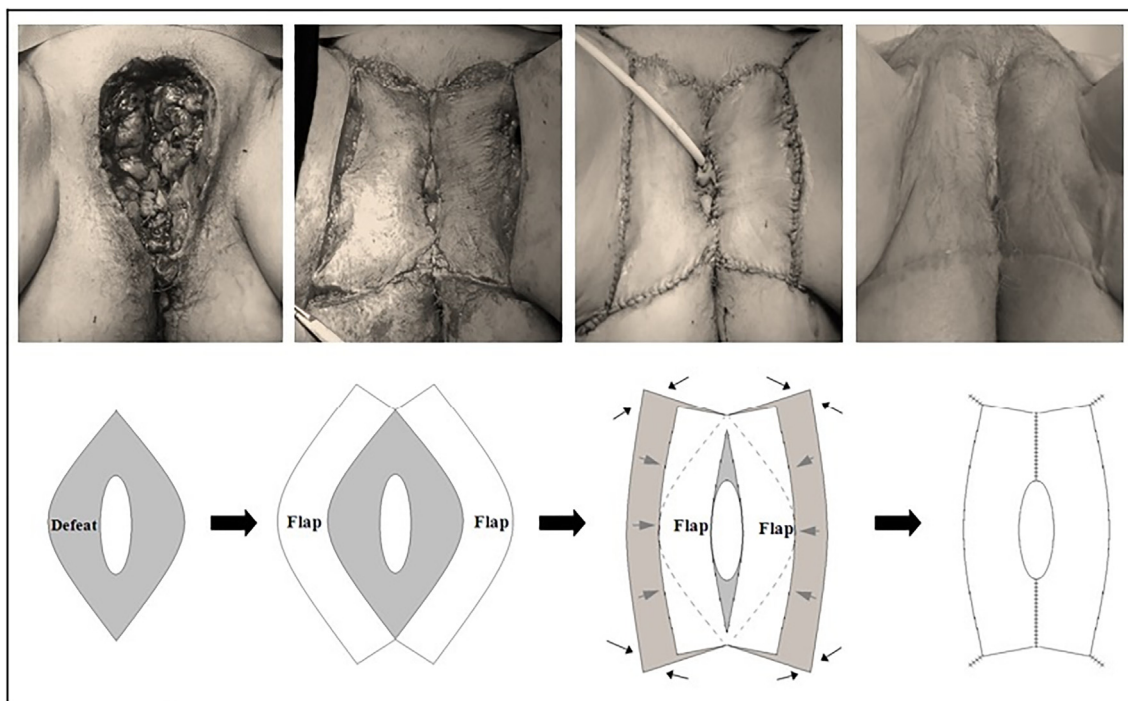


Fig. 1. Key stone technique.

Table 1
Demographic, clinical and surgical characteristics of the study group.

Patient	Age, y	BMI, kg/m ²	Comorbidity	Histopathology	FIGO stage 2009	Surgical Outcomes		
						Operative time (min)	Blood loss (mL)	Hospital stay (days)
1	60	22.1	I, C	SCVC	IB	345	150	9
2	82	35.1	I, C, DM, TD	SCVC	IB	300	100	10
3	66	38.5	I, DM, TD	SCVC	IIIA	470	200	8
4	66	29.0	C, TD	PD	/	95	50	4
5	71	24.8	I, TD	SCVC	IIIC	355	500	10

Note: SCVC, Squamous Cell Vulvar Cancer, PD, Paget Disease, TD, Thyroid Disorders, I, Iperntension, DM, Diabetes Mellitus, C, Cancer history.

Table 2
Surgical complications, status disease, cosmetic outcomes of the study group.

Patient	Complications		Status Disease
	Short-term	Long-term	
1	None	None	NED
2	None	None	NED
3	Blood transfusion Dehiscence	Urinary incontinence	NED
4	None	None	NED
5	None	None	NED

Note: NED, no evidence of disease. AWD, alive with disease.

reconstruction following wide vulvar cancer excision. In the case of small excisions, direct closure could be applicable but lead to high rates of delayed healing and patient discomfort. Instead, large vulvar excisions should require tissue flaps to complete the repair (Sinna et al., 2013; Spear et al., 1994; Artioukh et al., 2007).

Skin grafting can be appropriate for superficial wounds such as those incurred by skinning vulvectomy for vulvar neoplasia, but its application is not feasible because it can leave an undesirable donor site scar during re-epithelialization, difficult immobilization of the graft and wound contamination (Carramaschi et al., 1999; Korlof et al., 1975).

V-Y advancement flaps are shaped like a V, and they are slid into the defect so that, after closure, the incision assumes a “Y” shape. Fasciocutaneous flaps have axial patterns that include a dedicated blood supply contributing rich vascularization and can be transferred to wide defects without the bulkiness of musculocutaneous flaps (Di Donato et al., 2017).

Pudendal thigh flaps are based on the perforating vessels of the extensive anastomotic network of the pudendal, obturator and circumflex arteries.

The lotus petal fasciocutaneous flap was described in 1996 by Yii and Nirajian, requiring isolation and preservation of deep perforators in the region and including the deep fascial layer (Yii and Nirajan, 1996). Recently, several groups have developed and modified lotus flaps, a commonly used flap is the modified pudendal thigh fasciocutaneous flap (Singapore) fed by the internal pudendal neurovascular supply (Sinna et al., 2010).

Myocutaneous flaps offer bulk for deep defects such as those encountered at the time of total exenteration or extended radical vulvectomy. In 1976, McCraw et al. introduced the gracilis flaps, an attractive choice for vulvo-vaginal reconstruction, but the mobility is limited by the circumflex artery pedicle and creates donor site morbidity (McCraw et al., 1976).

Abdominal flaps, while reliable, leave important abdominal sequelae and can be bulky for vulvar reconstruction (Boccaro et al., 2018). The versatility of these flaps has allowed its use in many clinical conditions, and each surgical approach should be tailored to the local defect.

We believe that the KPIF flap has many advantages compared with other reconstructive methods. The V-Y advancement flap has important scars that cross the gluteal fold, resulting in sitting and walking discomfort. The rhomboid transposition flap is mainly valuable for

posterior vulvar defects with a limitation in the size for the reconstruction of large defects.

We found that the Keystone technique is an extremely simple and effective solution, easily applicable and reproducible. Compared with subcutaneous pedicle flaps, the Keystone flap technique warrants a better vascular supply by additionally preserving musculocutaneous and fasciocutaneous perforator vessels and does not require delicate perforator dissection. Additionally, it is associated with minimal morbidity in donor sites, a lower risk of flap necrosis and lower intraoperative and postoperative complications (Behan, 2003; Pelissier et al., 2007; Pelissier et al., 2007).

The Keystone flap method yields good aesthetic and functional results by preserving shape and contour, avoiding differences in skin coloration and preserving sensitivity with an excellent cosmetic outcome in terms of patient satisfaction and postoperative scars and with an acceptable complication rate.

Although the Keystone flap remains largely unknown in vulvo-perineal reconstructive surgery, after analyzing the positive results of this small series, we believe that it should be considered in vulvar reconstructive surgery techniques for the closure of soft-tissue defects after extensive surgery for vulvar cancer. Further studies with larger sample size are required to evaluate the efficacy of this technique.

Author contributions

Michele Peiretti: Study conception and design, acquisition of the data, writing of the manuscript, text revision.

Elisabetta Corvetto: Analysis and interpretation of the data, drafting of the manuscript.

Giorgio Candotti: Data analysis, critical text revision, English corrections.

Stefano Angioni: Data collection, critical text revision.

Andrea Figus: Data collection, surgical technique revision, critical text revision.

Valerio Mais: Study conception, data collection, paper writing, critical text revision.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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