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Case Series

Perineal reconstruction with pedicled rectus abdominis myocutaneous flap after posterior pelvic exenteration –A 3D model study

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ABSTRACT

INTRODUCTION: Limited literature exists regarding the positional relationship between the pedicled-rectus abdominis myocutaneous (p-RAMC) flap and residual pelvic organs post posterior pelvic exenteration (PPE).
PRESENTATION OF CASE: Four patients underwent PPE and reconstruction with a p-RAMC flap. After harvesting the p-RAMC flap with the deep inferior epigastric artery and veins as the vascular pedicle, the intra-pelvic shortest pathway of the flap was created. We dissected the subcutaneous tissues of the flap donor site toward the perineal defect along the inner wall of the pelvis. The pubic origin of the rectus abdominis muscle was preserved. A three-dimensional model was constructed using an image processing software. The vascular pedicle ran almost linearly along the inner wall of the pelvis. The muscle belly was placed on the pelvic floor through the posterior wall of the urinary bladder which filled the dead space of the resected area. All flaps survived without significant complications.
DISCUSSION: Assigning the cranial side of the flap to the perineum and caudal side to the pelvic floor could reduce postoperative intrapelvic complications. By preserving the pubic origin of the rectus abdominis muscle, a shock absorber of the pedicle of the flap was created, preventing over-traction of the flap while passing through the intrapelvic pathway.
CONCLUSION: A p-RAMC flap via intra-pelvic shortest pathway is an ideal reconstructive method for large skin defect in perineal area after PPE.

1. Introduction

Surgical resection of pelvic malignancies, referred to as pelvic exenteration, is classified into three groups according to the resection area [1]. All pelvic organs are removed during total pelvic exenteration (TPE). In contrast, the rectum is preserved in anterior pelvic exenteration and the urinary bladder in posterior pelvic exenteration (PPE). PPE is commonly performed for colorectal malignancies without tumour invasion into the urinary bladder. Preservation of the urinary bladder is associated with better quality of life compared to TPE.

After pelvic exenteration, reconstruction occurs. The gracilis myocutaneous flap is a pliable flap that can reduce donor site morbidity. However, postoperative pelvic inflammation occurs more frequently than that of the rectus abdominis myocutaneous flap because the former does not offer enough tissue to fill the dead space after pelvic exenteration [2]. The omental flap is suitable for that space but must be combined with a skin flap to close the large skin defect [3].

The pedicled rectus abdominis myocutaneous (p-RAMC) flap provides sufficient subcutaneous tissues for reconstruction after pelvic exenteration with perineal skin defects. However, there is a paucity of detailed literature on the positional relationship between the flap and the residual organs in detail. We analysed our reconstructive procedures using a three-dimensional (3D) model of the postoperative pelvis, made from a follow-up computed tomography (CT).

This case series study has been reported in line with the SCARE criteria and the PROCESS criteria [4].

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2. Presentation of case

This study included four consecutive patients (two men and two women; mean age, 70.3) who underwent PPE and immediate reconstruction with a p-RAMC flap in Kobe University Hospital between January 2016 and October 2020. Using medical records, the patients' demographics and medical history were retrospectively investigated. Familial cancer history is mentioned if present.

Two patients had advanced rectal cancer, one had anal canal cancer, and one had anal fistula cancer (Table 1). All patients received preoperative chemotherapy with capecitabine (3000 mg/d for 3 weeks) and concurrent radiotherapy (50.4 Gy in 28 fractions). PPE was performed including lateral lymph node dissection by board certified gastroenterological surgeons. The skin around the anal and perineal areas was resected in all cases, due to malignant tumour invasion.

Plastic surgeons harvested the p-RAMC flap for immediate reconstruction of the perineal defect. The right abdomen was the flap donor site in all cases because the opening of loop-colostomy was made in the left upper quadrant of the abdomen. The subcutaneous tissue below the arcuate line at the donor site of the flap was dissected into the pelvis toward the perineal skin defect. The flap was moved to the perineum through the gap between the urinary bladder and the pelvic wall; henceforth referred to as the "intra-pelvic shortest pathway". The partial incision between the rectus abdominis muscle and the pubic symphysis extended the arc of rotation of the flap.

The flap survived completely in all cases, and all patients were discharged without significant postoperative complications. All cases were followed up by both gastroenterological and plastic surgeons in the outpatient clinic of Kobe University Hospital. The mean follow-up period was 13.0 months postoperatively. A 3D-CT model of postoperative pelvis was constructed from Digital Imaging and Communications in Medicine data using Ziostation 2^{TM} (Amine Co., Ltd., Tokyo, Japan).

2.1. Case 1

A 66-year-old man with advanced anal fistula cancer was referred to our department for reconstruction after tumour resection. He had been taking 10 mg/d of prednisolone for rheumatoid arthritis. Following neoadjuvant chemoradiotherapy, PPE was performed. The skin around the anal and perineal areas was resected due to the invasion of the malignant tumour beyond the dentate line. The skin and subcutaneous tissue defect extended from the scrotum to the end of the coccyx (Fig. 1a).

Although the patient had a history of cholecystectomy with a skin incision on the right hypochondriac area, right deep inferior epigastric artery and veins were intact (Fig. 1b). The flap was moved to the perineum through the intra-pelvic shortest pathway (Fig. 1c).

The oncologist performed a contrast CT scan for the follow-up study of the malignant tumour. The 3D model revealed that the vascular pedicle of the flap passed linearly along the pelvic wall (Fig. 2b). The muscle belly filled the dead space as it was placed on the pelvic floor through the back of the bladder. The cranial side of the flap was in the perineum of the defect, and the caudal side was located on the coccygeal side (Fig. 2c). After hospital discharge, he has lived without tumour recurrence for 6 months.

2.2. Case 2

A 66-year-old man with diabetes mellitus received PPE for advanced rectal cancer following neoadjuvant chemoradiotherapy. His mother had colorectal cancer in her 80′s. The primary site of malignancy, including the anal and perineal skin, was resected. The urinary bladder and prostate were preserved.

A p-RAMC flap was harvested from the right abdomen for the reconstruction of the perineal defect. The flap and vascular pedicle of the flap was passed through the intra-pelvic shortest pathway. The patient was followed 8 months postoperatively.

2.3. Case 3

A 79-year-old woman with advanced rectal cancer underwent PPE after preoperative chemotherapy and radiotherapy. The rectum, perianal skin, and vaginal posterior wall were resected due to the extension of cancer.

The p-RAMC flap was harvested from the right abdomen. The pubic origin of the rectus abdominis muscle was mostly incised, but the continuity of the muscle was preserved (Fig. 3a). The uterine broad ligament beside the urinary bladder was partially dissected to create the intra-pelvic shortest pathway (Fig. 3b). The vaginal posterior wall and perineal defect was reconstructed with the cranial side of the p-RAMC flap (Fig. 3c).

A postoperative 3D-CT model revealed that the vascular pedicle and the muscle belly passed through the broad ligament of the uterus (Fig. 2d, e, f). She had no major clinical sequelae 12 months after the surgery.

2.4. Case 4

A 70-year-old woman without any medical history underwent PPE for advanced anal canal cancer. The rectum and anus were resected with a wide skin margin. The urinary bladder and uterus were preserved. The defect was reconstructed with a p-RAMC flap which was harvested from the right abdomen. To build the intra-pelvic shortest pathway of the flap, the uterine broad ligament was partially dissected.

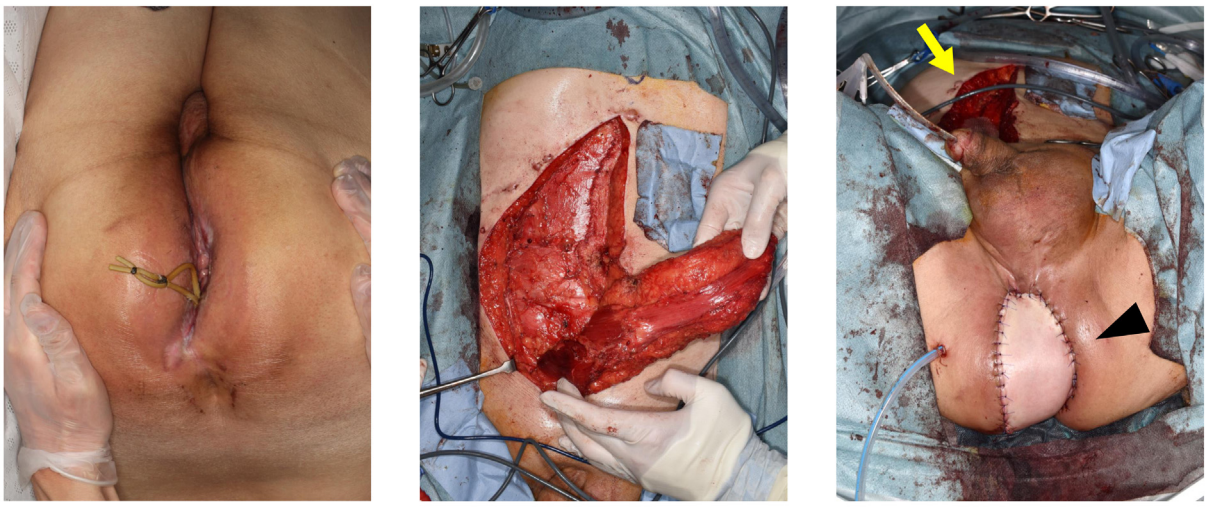
She received 3 g of tazobactam/piperacillin every 6 h for 2 weeks due to postoperative fever-up. Follow-up CT two years later demonstrated metastasis of the tumour to the cervical spine, which needed palliative radiation therapy. She has been visiting our outpatient clinic more than 26 months postoperatively.

3. Discussion

The distally based p-RAMC flap is a myocutaneous flap with the vascular pedicle of the deep inferior epigastric artery and veins, which branches from the common iliac artery and vein [5]. As the p-RAMC flap offers a well-vascularised large volume of soft tissue, it is commonly used for reconstruction of skin defects at the perineum.

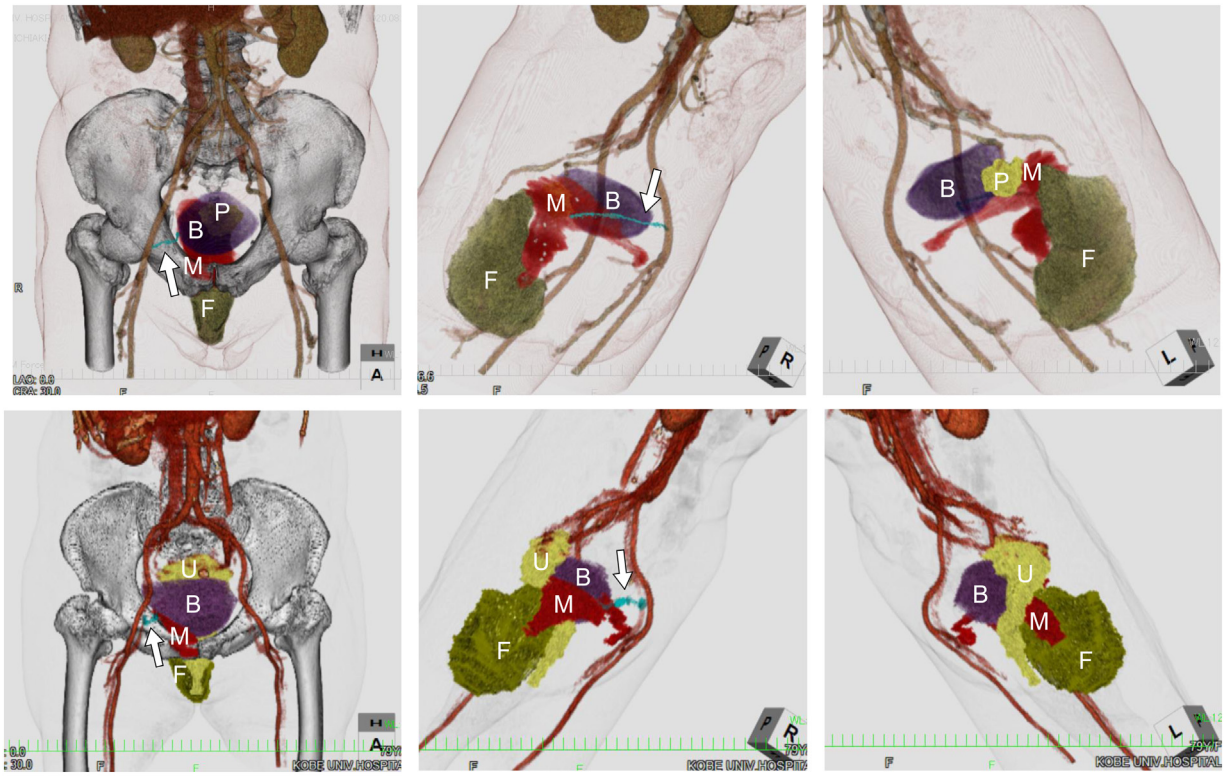
We studied the route of the vascular pedicle of the p-RAMC flap and the positional relationship between the flap and the residual organs after pelvic exenteration. After TPE, there were no residual organs on the straight line from the bifurcation point of the vascular pedicle to the perineal defect (Fig. 4a). Thus, the caudal side of the flap was assigned to the perineum and cranial side to the pelvic floor [6]. In contrast to TPE, PPE involves the removal of the rectum and preservation of the urinary bladder. Therefore, the intra-pelvic shortest pathway of the vascular pedicle is directed toward the pelvic floor, avoiding the residual urinary bladder [7]. As a result, the cranial side of the flap is assigned to the perineum and the caudal side to the pelvic floor (Fig. 4b). This reconstruction method fills the dead space with the flap muscle belly.

Sagebiel et al. described the intra-pelvic shortest pathway of p-RAMC flap after PPE [8]. They created a 3D-CT model of the vascular pedicle and the flap but did not emphasise the positional relationship between the flap and the residual organs. Our 3D-model study revealed that the vascular pedicle travelled almost linearly from the bifurcation point to the pelvic floor between the urinary bladder and the pelvic wall. Preserving the pubic origin of the rectus



a | b | c

Fig. 1. Operative findings (Case 1).
a) Preoperative examination suggest that the malignant tumour invaded beyond the dentate line. b) A 22 × 6 cm pedicled-vertical rectus abdominis myocutaneous flap is harvested. c) The flap is pulled from the donor site (arrow) to the perineal skin defect (arrowhead) along the intra-pelvic shortest pathway.



a | b | c
d | e | f

Fig. 2. Three-dimensional model of the reconstructed pelvic floor.
Case 1: a) Anterior view. The vascular pedicle (arrow) and the muscle belly pass through the space between the urinary bladder and the pelvic wall. b) Right lateral view. The vascular pedicle (arrow) is connected to the common iliac artery and the flap through a linear course along the urinary bladder. c) Left lateral view. The urinary bladder and prostate gland are covered with the muscle belly of the flap.
Case 3: d) Anterior view. The vascular pedicle (arrow) and the muscle belly pass through the space between the residual organs and the pelvic wall. e) Right lateral view. The muscle belly of the flap is located on the right side of the uterus. f) Left lateral view. The flap fills the dead space behind the urinary bladder and the uterus.
Legends: Arrow, vascular pedicle; B, urinary bladder; U, uterus; M, muscle belly; F, flap.

Table 1
Case report file.

No.	Age (year)	Sex	Site of malignancy	Comorbidities	Pre-op CRT	Operation	Reconstruction	Flap donor side	Complication	Follow-up (months)
1	66	M	Anal fistula	RA	+	PPE	p-RAMC flap	Right	None	6
2	66	M	Rectum	DM	+	PPE	p-RAMC flap	Right	None	8
3	79	F	Rectum	–	+	PPE	p-RAMC flap	Right	None	12
4	70	F	Anal canal	–	+	PPE	p-RAMC flap	Right	None	26

Abbreviations: RA, rheumatoid arthritis; DM, diabetes mellitus; CRT, chemoradiotherapy; PPE, posterior pelvic exenteration; p-RAMC, pedicled-rectus abdominis myocutaneous.

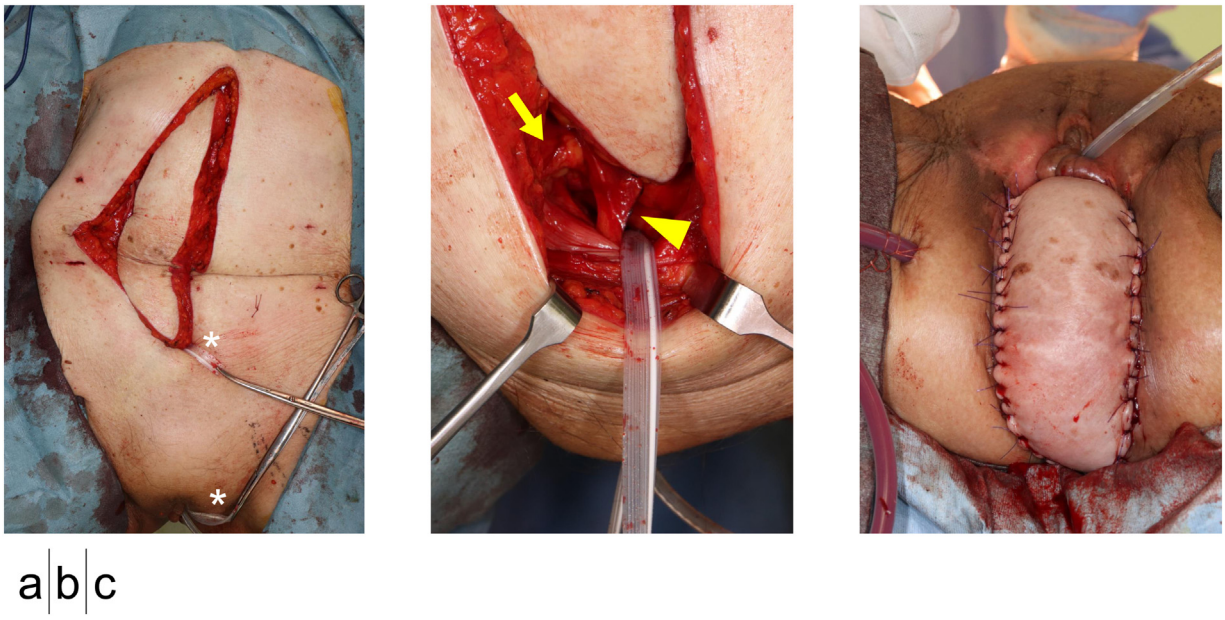


Fig. 3. Operative findings (Case 3).
a) A silicone tube is inserted through the intra-pelvic shortest pathway (asterisk). b) The vascular pedicle of the flap (arrow) and the preserved rectus abdominis muscle (arrowhead). The broad ligament of the uterus beside the urinary bladder is partially dissected. c) The posterior wall of the vagina and perineal defect are reconstructed with the cranial side of the flap.

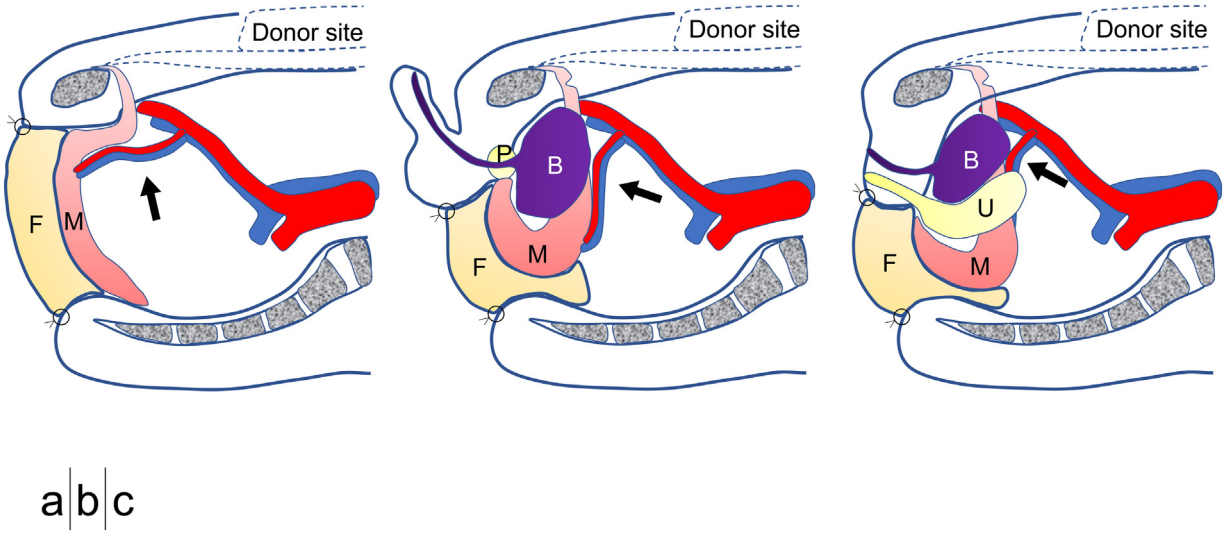


Fig. 4. Schema of the intra-pelvic shortest pathway.
a) After total pelvic exenteration, the intra-pelvic shortest pathway is horizontal to the abdominal wall. b) After posterior pelvic exenteration, the vascular pedicle of the flap is directed to the pelvic floor, which is vertical to the abdominal wall, to avoid the residual urinary bladder. c) The broad ligament of the uterus when the uterus is preserved in women with posterior pelvic exenteration.
Legends: Arrow, vascular pedicle; B, urinary bladder; P, prostate; U, uterus; M, muscle belly; F, flap.

abdominis muscle prevented the avulsion injury of the vascular pedicle.

The uterine broad ligament was dissected to create the intra-pelvic shortest pathway, when the uterus was preserved in patients who underwent PPE (Fig. 4c). The postoperative 3D-CT model of Case 2 indicated that the muscle belly and the vascular pedicle of the flap were passed through the dissected broad ligament.

4. Conclusion

Our pelvic floor reconstruction method with a p-RAMC flap via intra-pelvic shortest pathway and postoperative 3D-CT model demonstrated that the cranial and caudal sides of the flap were assigned to the perineum and the pelvic floor, respectively. The pelvic dead space was filled with the muscle belly of the flap, which prevented postoperative infection of the area. This is a reliable reconstructive method for large skin defects in the perineal area following PPE.

Declaration of Competing Interest

The authors report no declarations of interest.

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None.

Ethical approval

This study was approved by the ethics committee of the clinical translational research center of Kobe University Hospital (approval number: B200314).

Consent

Written informed consent was obtained from all patients for the publication of this article, including the figures.

Author contribution

Daiki Kitano, Takeo Osaki, and Kazunobu Hashikawa performed the operative procedures. Daiki Kitano, Takeo Osaki, and Shunsuke Sakakibara drafted the manuscript, including grammar check. Tadashi Nomura, Kazunobu Hashikawa, and Hiroto Terashi supervised the operations and this manuscript.

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