# Accessory polar renal artery encountered in transperitoneal systemic laparoscopic paraaortic lymphadenectomy

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**Summary**

*Objective:* To increase vigilance among gynecological surgeons for the presence of accessory polar renal artery (APRA) encountered with transperitoneal systemic laparoscopic paraaortic lymphadenectomy (LPAL). *Methods:* A retrospective review was conducted on 156 women who underwent LPAL for various gynecologic malignancies between November 2003 and December 2009. *Results:* The median age, parity, body mass index, and number of previous abdominal surgeries, respectively, of the women were 52 years (range, 23-82 years), two (range, 0-7), 24.1 kg/m$^2$ (range, 17.4-35.0 kg/m$^2$), and 0 (range, 0-3). During the study period, we found four women with APRA. There were three cases of right lower APRAs arising from the abdominal aorta, caudal to the inferior mesenteric artery (IMA), terminating at the parenchyma of the lower pole of the right kidney. In the other case, the APRA arose from the abdominal aorta superior to the IMA. There were no vascular complications, such as transection or ligation of the APRA. *Conclusion:* It is important for the gynecological oncologic surgeon to have knowledge of retroperitoneal vascular anatomy, experience in laparoscopic surgery, and an accurate surgical technique to avoid vascular injury during LPAL.

*Key words:* Accessory polar renal artery; Gynecology; Laparoscopy; Lymphadenectomy; Paraaortic lymph node.

## Introduction

Each kidney is generally supplied by a single renal artery that originates from the aorta at the level of the second lumbar vertebra, but there are variations in renal vascular anatomy. In the past, such vascular anomalies and variations were of concern mostly to renal transplant surgeons and vascular surgeons involved in procedures such as urologic and renal transplantation, vascular reconstruction, repair of abdominal aortic aneurysms, and renal artery stenosis. However, with the recent advancement of paraaortic lymphadenectomy in the field of gynecologic oncology, the importance of retroperitoneal and vascular anatomy is getting more attention from gynecologic surgeons as well. Considering the current widespread use of laparoscopic surgery in gynecologic oncology, an awareness of renal vascular anatomy is important, especially for arterial variations. This knowledge is essential in the prevention of inadvertent transection or ligation of variant renal arteries, which can lead to renal segmental ischemia or even renal infarction [1-3].

The purpose of this study was to analyze the incidence and clinical significance, to increase vigilance of an accessory polar renal artery (APRA) as encountered by transperitoneal systemic laparoscopic paraaortic lymphadenectomy (LPAL) in order to minimize untoward vascular complications for gynecological oncologic surgeons.

## Methods

All procedures were performed by a single gynecologic surgical team in a single institution. A retrospective chart review was conducted on 156 women who underwent LPAL for various gynecologic malignancies in Kangbuk Samsung Hospital between November 2003 and December 2009. We reviewed clinical charts and analyzed data on patient age, parity, body mass index (BMI), history of previous abdominal surgery, number of patients per final diagnosis, FIGO stage of gynecologic malignancy, and any operative complications. All the patients provided written informed consent regarding any complications and the possibility of conversion to laparotomy. The history of previous abdominal surgery and BMI did not affect our decision to perform surgery.

Indications for LPAL up to the level of the left renal vein were any operable endometrial cancer regardless of stage and grade [4, 5]. For patients with ovarian cancer, fallopian tube cancer, or primary peritoneal cancer, LPAL was performed when optimal debulking surgery was expected from laparoscopy [6]. With cervical cancer, LPAL to the level of the left renal vein was performed in FIGO stage IB1 with larger than 2 cm in size, IB2, and IIA and also when pelvic or paraaortic lymph node metastasis was confirmed on frozen section analysis in FIGO Stage IB1 with the tumor size less than 2 cm. LPAL at the level of the inferior mesenteric artery (IMA) instead of the left renal vein was performed in patients with cervical cancer FIGO Stage IB1 with tumor less than 2 cm in size and no evidence of lymph node metastasis during surgery on frozen section analysis. For borderline ovarian tumors, patients underwent LPAL when frozen section analysis showed papillary serous cell types or a suspicion of ovarian cancer.

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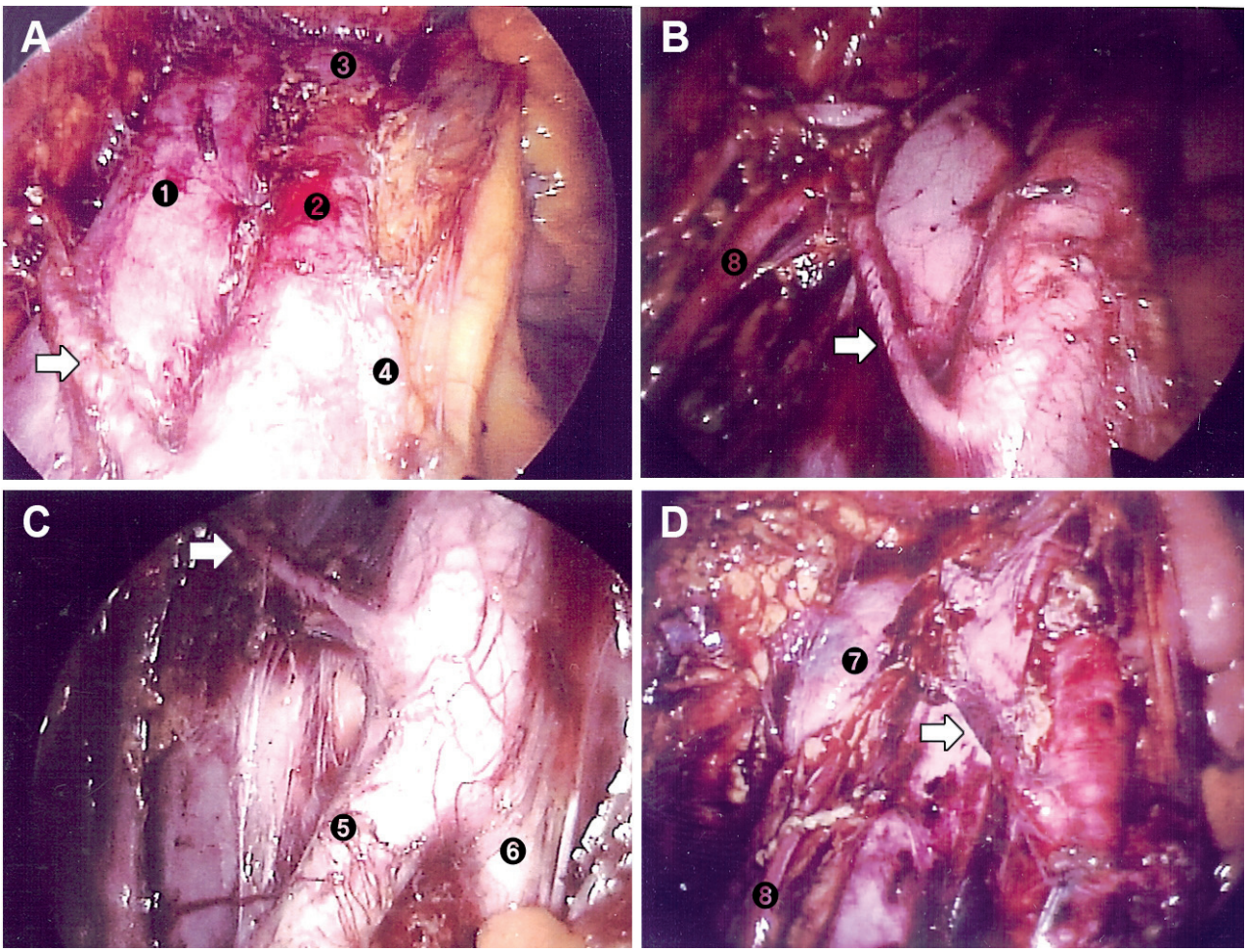


Figure 1. — Pictures of APRAs (white arrows) taken during LPAL ① inferior vena cava, ② abdominal aorta, ③ left renal vein, ④ inferior mesenteric artery, ⑤ right common iliac artery, ⑥ left common iliac artery, ⑦ right kidney, ⑧ right ureter.

## Results

A total of 156 women underwent LPAL during the study period. The median age of the women was 52 years (range, 23-81 years) and the median parity was two (range, 0-7). The median BMI was 24.1 kg/m$^2$ (range, 17.4-35.0 kg/m$^2$) and the median number of previous abdominal surgeries was 0 (range, 0-3). Table 1 shows the patient distribution of each gynecologic malignancy and FIGO stage. Four patients had an APRA. Three had a right lower APRA arising from the abdominal aorta inferior to the IMA, terminating at the parenchyma of the lower pole of the right kidney. In the other patient, the polar artery arose from the abdominal aorta superior to the IMA (Figure 1). The base-line characteristics, name of laparoscopic procedures, final histopathologic diagnosis, and follow-up of these four patients are shown in Table 2. There were no vascular complications with the APRA such as transection or ligation. In all patients with APRA, multidetector-row computed tomography (MDCT) angiogram was performed postoperatively to identify other associated vascular anomalies (Figure 2).

Figure 2. — Postoperative MDCT angiogram of patient B. Note the two different right renal arteries arising from the abdominal aorta supplying the upper and lower poles of the right kidney. The lower vessel is a right lower accessory polar artery measuring 4 mm in diameter, which is narrower than the upper main renal artery measuring 10 mm in diameter.

Table 1. — *Patient distribution of each gynaecologic malignancy and FIGO stage*.

| | FIGO Stage | Number of patients |
|---|---|---|
| Cervical cancer (n = 77) | IB1 | 27 |
| | IB2 | 31 |
| | IIA2 | 4 |
| | IIB | 15 |
| Endometrial cancer (n = 44) | IA | 27 |
| | IB | 5 |
| | II | 2 |
| | IIIA | 1 |
| | IIIC1 | 3 |
| | IIIC2 | 6 |
| Ovarian cancer (n = 27) | IA | 2 |
| | IB | 3 |
| | IC | 7 |
| | IIA | 2 |
| | IIC | 1 |
| | IIIB | 2 |
| | IIIC | 10 |
| | IIIC | 3 |
| Borderline ovarian tumor (n = 5) | IA | 1 |
| | IB | 1 |
| | IC | 1 |
| | IIC | 1 |
| | IIIC | 1 |
| Primary peritoneal cancer (n = 1) | IIIA | 1 |
| Tubal cancer (n = 2) | IIB | 1 |
| | IIIC | 1 |

## Discussion

Arterial or venous abnormalities of the kidneys are relatively common and have been reported in up to 25-40%. The most frequent variation among these anomalies is the APRA, which has also been called the "aberrant," "anomalous," "supernumerary," "lower polar," and "accessory polar," artery because there is no universal agreement regarding its nomenclature [1, 7]. Here we use the term APRA to avoid confusion. The incidence of APRA varies widely. APRA occurs unilaterally or bilaterally as single or double vessels with a frequency of 9-31.3% [8]. Khamanarong et al. reported an overall incidence of 7.32% and 3.56% for upper and lower polar arteries, respectively [2]. The overall incidence of single aberrant vessels is similar between the right and the left kidney, but Kappor *et al*. reported that it was more common on the right than the left using multispiral computed tomographic angiography (MSCTA), which is more sensitive than conventional methods of detecting aberrant vessels less than 2 mm in diameter [9]. Klemm *et al*. reported that 13 APRAs were found in 9/86 patients (10.4%) who underwent laparoscopic infrarenal paraaortic lymphadenectomy. In that study with 13 subjects, eight cases were right lower APRAs and five cases were left lower APRAs [10]. Moreover, there is a significant difference in the incidence and location of APRAs that exist between sex and race [11]. Hence, in our Korean women study, only four women (2.56%) with APRAs were detected.

Why polar vessels develop is not clearly understood, but these vessels are clinically important because they might represent segmental arteries supplying a particular area of the kidney. APRAs are end arteries with no anastomoses or collateral circulation. Therefore, intraoperative, inadvertent transection, ligation, or occlusion of these arteries can cause segmental ischemia or infarction. This might need to be managed with segmental resection of the kidney because irreversible damage can occur in the renal parenchyma unless revascularization is performed within two hours [1]. However, the safe warm ischemia time is only 30 minutes in the literature on partial nephrectomy [12]. If renal infarction is diagnosed postoperatively during the evaluation of fever or flank pain, continued monitoring of kidney function and blood pressure is necessary because it can lead to postoperative hypertension [1, 2, 10, 11, 13]. Moreover, APRAs tend to be longer and narrower than the main renal arteries, resulting in lower perfusion pressure and higher resistance across the artery. This can lead to renovascular hypertension even without vascular injury [3]. APRAs most often pass anterior to the ureter, and such a retroureteral variant is likely to be associated with ureteropelvic junction obstruction and hydronephrosis [7]. There is a higher chance of accompanying ovarian and ureteral abnormalities if APRAs exist bilaterally [7].

Paraaortic lymphadenectomy is an indispensable surgi-

Table 2. — *Clinical characteristics of the patients with accessory polar renal artery.*

| Patients | Age (years) | Final diagnosis | Operative procedures | Postoperative treatment | Follow-up |
|---|---|---|---|---|---|
| A | 52 | Endometrial adenocarcinoma, Stage IA | LAVH with BSO, LPL, LPAL, LA, Peritoneal washing cytology | None | NED |
| B | 61 | Primary peritoneal cancer, Stage IIIC | Extrafascial LAVH with BSO, LPL, LPAL, LO, LA, multiple peritoneal biopsy, peritoneal washing cytology | Taxol-carboplatin chemotherapy | AWD in second line chemotherapy |
| C | 35 | Invasive SCC of the uterine cervix Stage IIA | LRVH, LPL, LPAL, LA, LBOT | Concurrent chemoradiation (weekly cisplatin) | NED |
| D | 54 | Endometrial adenocarcinoma Stage IIIA | LAMRVH with BSO, LPL, LPAL, LA, peritoneal washing cytology | Concurrent chemoradiation (with taxol-carboplatin) | NED |

LAVH: laparoscopically assisted vaginal hysterectomy; BSO: bilateral salpingo-oophorectomy; LPL: laparoscopic pelvic lymphadenectomy; LPAL: laparoscopic paraaortic lymphadenectomy; LA: laparoscopic appendectomy; LO: laparoscopic omentectomy; LAMRVH: laparoscopic assisted modified radical vaginal hysterectomy; LRVH: laparoscopic radical vaginal hysterectomy; SCC: squamous cell carcinoma; LBOT: laparoscopic bilateral ovarian transposition; NED: no evidence of disease; AWD: alive with disease.

cal procedure in deciding the surgical stage and prognosis of gynecological malignancies. As long as gynecologic surgeons perform these procedures, encounters with these anomalies will be inevitable. In our experience, the IMA tends to branch from the left of the midline of the abdominal aorta to supply the hindgut, which makes the LPAL procedure seem easier to perform on the right side than the left. However, unexpected hemorrhage can occur if there is vascular injury to the APRA on the right side. If the vascular injury is identified during surgery, segmental loss of renal parenchyma can be prevented by anastomosis or vessel reimplantation with the help of a vascular surgeon before ischemia develops. However, if the diagnosis is made afterwards, it is hard to salvage that portion of kidney because these vessels are end arteries without collateral circulation. Moreover, vascular injury complicated by severe intraoperative hemorrhage can lead to more technically challenging and therefore less accurate surgery [13]. Therefore, both novice and experienced trainees should take care to avoid vascular injuries associated with an ARPA.

## Conclusions

To avoid vascular injury during LPAL, it is important for the gynecological oncologic surgeon to have knowledge of retroperitoneal vascular anatomy, experience in laparoscopic surgery and accurate surgical technique to ensure adequate exposure, careful dissection, and surgical stage and prognosis of gynecological malignancies. As long as gynecologic surgeons perform these procedures, encounters with these anomalies will be inevitable. In our experience, the IMA tends to branch from the left of the midline of the abdominal aorta to supply the hindgut, which makes the LPAL procedure seem easier to perform on the right side than the left. However, unexpected hemorrhage can occur if there is vascular injury to the APRA on the right side. If the vascular injury is identified during surgery, segmental loss of the renal parenchyma can be prevented by anastomosis or vessel reimplantation with the help of a vascular surgeon before ischemia develops. However, if the diagnosis is made afterwards, it is hard to salvage that portion of kidney because these vessels are end arteries without adequate oncologic outcome.

## References

[1] Eitan R., Abu-Rustum N.R., Walker J.L., Barakat R.R.: "Ligation of an anatomic variant of renal vasculature during laparoscopic periaortic lymph node dissection: a cause of postoperative renal infarction". *Gynecol. Oncol.,* 2003, *91*, 416.
[2] Khamanarong K., Prachaney P., Utraravichien A., Tong-Un T., Sripaoraya K.: "Anatomy of renal arterial supply". *Clin. Anat.* 2004, *17,* 334.
[3] Shakeri A.B., Tubbs R.S., Shoja M.M., Pezeshk P., Farahani R.M., Khaki A.A. *et al.*: "Bipolar supernumerary renal artery". *Surg. Radiol. Anat.*, 2007, *29,* 89.
[4] Lee J.H., Jung U.S., Kyung M.S., Choi J.S.: "Laparoscopic-assisted staging surgery for Korean women with endometrial cancer". *JSLS*, 2008, *12*, 150.
[5] Lee J.H., Jung U.S., Kyung M.S., Hoh J.K., Choi J.S.: "Laparoscopic systemic retroperitoneal lymphadenectomy for women with low-risk early endometrial cancer". *Ann. Acad. Med. Singapore*, 2009, *38*, 581.
[6] Jung U.S., Lee J.H., Kyung M.S., Choi J.S.: "Feasibility and efficacy of laparoscopic management of ovarian cancer". *J. Obstet. Gynaecol. Res.*, 2009, *35*, 113.
[7] Singh G., Ng Y.K., Bay B.H.: "Bilateral accessory renal arteries associated with some anomalies of the ovarian arteries: a case study". *Clin. Anat.*, 1998, *11*, 417.
[8] Gesase A.P.: "Rare origin of supernumerary renal vessels supplying the lower pole of the left kidney". *Ann. Anat.*, 2007, *189*, 53.
[9] Kapoor A., Mahajan G., Singh A., Sarin P.: "Multispiral computed tomographic angiography of renal arteries of live potential renal donors: a review of 118 cases". *Transplantation*, 2004, *77,* 1535.
[10] Klemm P., Frober R., Kohler C., Schneider A.: "Vascular anomalies in the paraaortic region diagnosed by laparoscopy in patients with gynaecologic malignancies". *Gynecol. Oncol.*, 2005, *96*, 278.
[11] Satyapal K.S., Haffejee A.A., Singh B., Ramsaroop L., Robbs J.V., Kalideen J.M.: "Additional renal arteries: incidence and morphometry". *Surg. Radiol. Anat.*, 2001, *23*, 33.
[12] Simmons M.N., Schreiber M.J., Gill I.S.: "Surgical renal ischemia: a contemporary overview". *J. Urol.*, 2008, *180*, 19.
[13] Benedetti-Panici P., Maneschi F., Scambia G., Greggi S., Mancuso S.: "Anatomic abnormalities of the retroperitoneum encountered during aortic and pelvic lymphadenectomy". *Am. J. Obstet. Gynecol.*, 1994, *170*, 111.

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