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"Ovarian Vascular Pedicle" Sign Revealing Organ of Origin of a Pelvic Mass Lesion on Helical CT

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OBJECTIVE. We evaluated the "ovarian vascular pedicle" sign as a way of differentiating ovarian from subserosal uterine lesions on single-detector helical CT.

SUBJECTS AND METHODS. We prospectively evaluated 131 patients who had a pelvic mass suspected of originating in the ovary or subserosal zone of the uterus and had undergone helical CT before surgery. A total of 108 ovarian lesions and 23 subserosal uterine myomas were confirmed. CT images were analyzed prospectively by consensus of two radiologists who thoroughly evaluated the retrograde tracing of the gonadal veins to the ovary or pelvic mass. To assess the value of analyzing the ovarian vascular pedicle sign in identifying the organ of origin of a pelvic mass, we compared statistical proportions for the frequencies of the sign in ovarian tumors and subserosal uterine myomas by performing the chi-square test. The probabilities for the presence of the ovarian vascular pedicle sign as a positive finding for a pelvic mass of ovarian origin were calculated.

RESULTS. The presence of the ovarian vascular pedicle sign was identified in 92% (99/108) of ovarian masses and in 13% (3/23) of subserosal uterine myomas. The sign was statistically significant ($p < 0.01$) for differentiating a mass of ovarian origin from a mass of subserosal uterine origin. When the ovarian vascular pedicle sign on helical CT confirmed the ovarian origin, the sensitivity, specificity, positive predictive value and negative predictive value, and diagnostic accuracy were 92% (99/108), 87% (20/23), 97% (99/102), 69% (20/29), and 91% (119/131), respectively.

CONCLUSION. The presence of the ovarian vascular pedicle sign on helical CT is valuable for confirming the ovarian origin of a pelvic tumor and for differentiating an ovarian tumor from subserosal uterine myoma.

The ovary is mainly supplied by the ovarian artery and drains into the ovarian vein. The ovarian veins form a plexus in the broad ligament that communicates with the uterine plexus by a dual blood supply. The ovarian vascular pedicle anatomically comprises the ovarian vessels exiting and entering the ovary with branches communicating with those of the uterine vessels. If an ovarian mass is present, the ipsilateral ovarian vessels may be enlarged. Using single-detector helical CT with optimal contrast enhancement and thin section, radiologists can evaluate retrograde tracing of the ovarian veins to the ovary because the gonadal veins are consistently shown anterior to the psoas muscle and the common iliac vessels on contiguous axial scanning. If a large pelvic mass originating from the ovary, uterus, bowel, and retroperitoneum is noted on CT, differentiation of the organ of origin of the pelvic mass may occasionally be unclear. The suspected origin of the mass is another important indication of a correct diagnosis obtained on imaging. We present the CT findings of the "ovarian vascular pedicle" sign to determine the organ of origin of a pelvic mass. Depiction of a direct joining of the asymmetrically enlarged gonadal veins with the pelvic mass indicates that the ovary is the organ of origin.

Our study was performed to determine statistical proportions for the frequencies of this ovarian vascular pedicle sign in ovarian tumors, subserosal uterine myomas, predominantly solid ovarian tumors, and subserosal uterine myomas and to determine the value of the ovarian vascular pedicle sign in differenti-

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ating ovarian tumors from subserosal uterine myoma on helical CT.

Subjects and Methods

We prospectively evaluated 131 patients, each with a pelvic mass suspected of originating in the ovary or subserosal zone of the uterus on the basis of the clinical diagnosis of their referring physician. All patients underwent helical CT before surgery at our institution between December 1999 and December 2001. A definite diagnosis for the pelvic mass was confirmed both surgically and pathologically in all patients. Patients ranged from 7 to 75 years old (mean age, 35 years). A total of 108 ovarian lesions were confirmed and comprised abscess (n = 5), endometrioma (n = 5), epithelial cystic tumor (n = 53), mature or immature teratoma (n = 17), dysgerminoma (n = 4), granulosa cell tumor (n = 2), fibroma or fibrothecoma (n = 6), and Krukenberg's tumor (n = 16). Their diameters ranged from 6 to 35 cm (mean, 12 cm). Twenty-four ovarian lesions were dominantly solid. A total of 23 subserosal uterine myomas were confirmed. Their diameters ranged from 6 to 25 cm (mean, 12 cm). Five lesions were dominantly cystic, and 19 lesions were dominantly solid. Postoperative specimens were available in all patients.

CT of the pelvis was performed using a helical scanner (Somatom Plus 4B, Siemens Medical System, Erlangen, Germany). A total of 150 mL of nonionic iodinated contrast agent (Ultravist [iopromide], 300 mg I/mL, Schering, Seoul, Korea) was administrated IV using a mechanical injector at a rate of 4 mL/sec. Oral contrast agent was not administered because it would obscure the ovarian veins necessary for the visualization of the ovarian vascular pedicle sign. The scanning delay was 70 or 120 sec. Scanning covered the area from the liver or renal hilum down through the pelvis. The scanning parameters were 120 kVp, 220 mAs, a 5- to 8-mm collimation, an 8-mm/sec table speed, and a 5-mm reconstruction interval.

The CT images were analyzed prospectively by consensus of two radiologists who did not have clinical information regarding the organ of origin of a pelvic mass and who thoroughly evaluated retrograde tracing of the gonadal veins to the ovary or the pelvic mass. The presence of the ovarian pedicle sign was defined as the gonadal veins directly joining the pelvic mass. The maximal outer diameters of both sides of the ovarian veins at the level of the aortic bifurcation in the ovarian tumor and subserosal uterine myoma were measured. To assess the value of analyzing the ovarian vascular pedicle sign in differentiating the organ of origin of a pelvic mass, we compared statistical proportions for the frequencies of the sign in ovarian tumors and subserosal uterine myomas and in predominantly solid ovarian tumors and subserosal uterine myomas by performing the chi-square test. The probabilities for the presence of the ovarian vascular pedicle sign as a positive finding for ovarian origin were then calculated.

Results

The presence of the ovarian vascular pedicle sign was identified in 92% (99/108) of ovarian masses (Fig. 1) and in 13% (3/23) of subserosal uterine myomas (Fig. 2). The sign was statistically significant for differentiating an ovarian origin of the mass from a subserosal uterine origin. The sign was identified in 92% (22/24) of predominantly solid ovarian masses (Fig. 3) and was statistically significant in differentiating them from subserosal uterine myomas. The maximal outer diameter of the ovarian vein at the level of the aortic bifurcation in the ovarian tumors ranged from 2 to 13 mm (mean, 9 mm) on the ipsilateral side and from 4 to 14 mm (mean, 5 mm) on the contralateral side. Seventy-

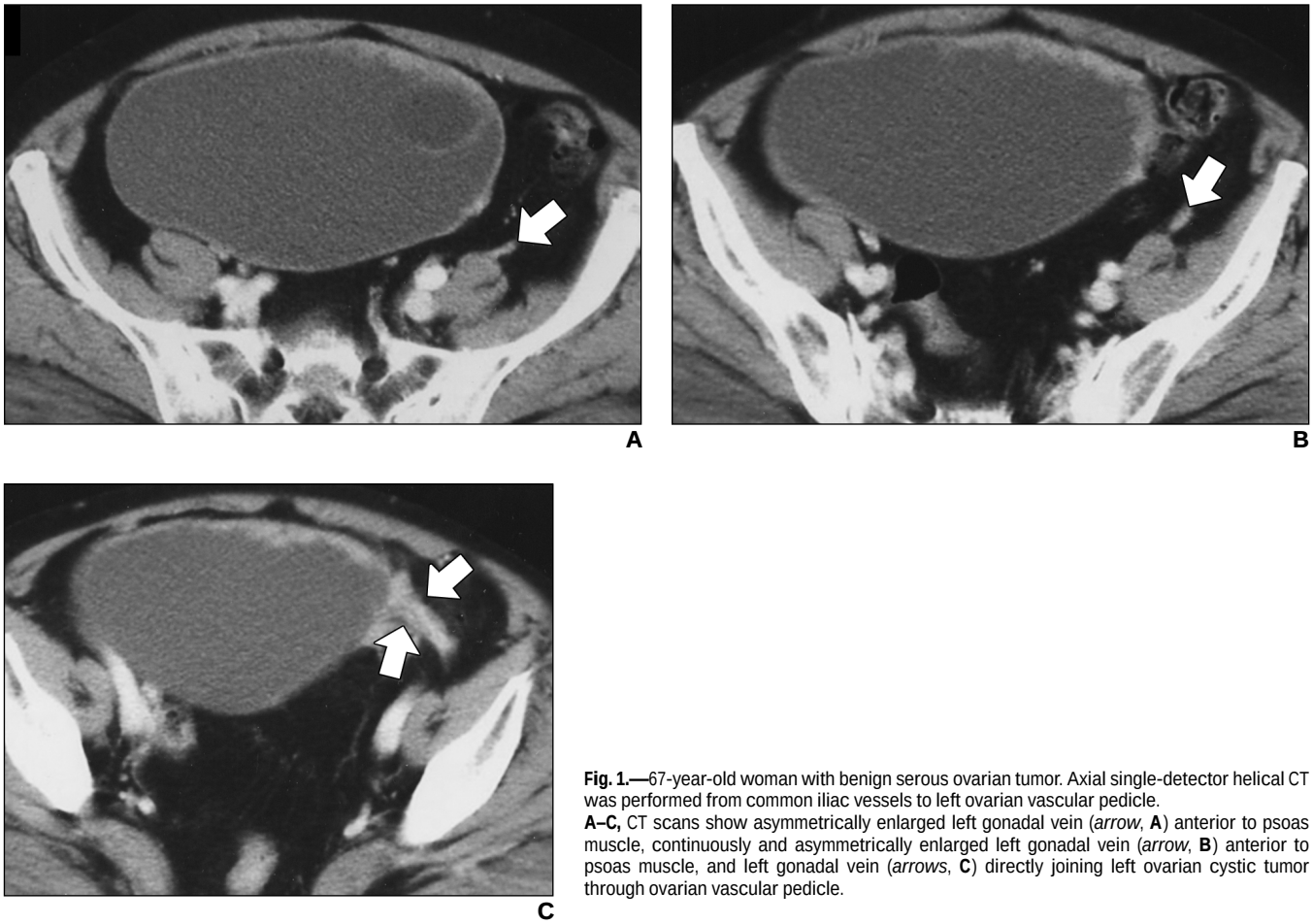


Fig. 1.—67-year-old woman with benign serous ovarian tumor. Axial single-detector helical CT was performed from common iliac vessels to left ovarian vascular pedicle.
A–C, CT scans show asymmetrically enlarged left gonadal vein (*arrow*, **A**) anterior to psoas muscle, continuously and asymmetrically enlarged left gonadal vein (*arrow*, **B**) anterior to psoas muscle, and left gonadal vein (*arrows*, **C**) directly joining left ovarian cystic tumor through ovarian vascular pedicle.

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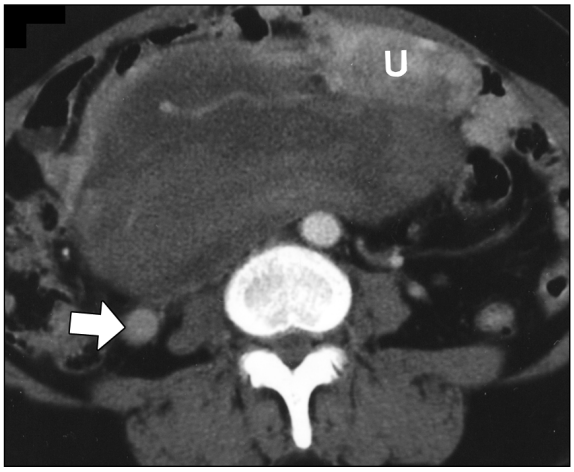
eight (72%) of the 108 ovarian tumors with the ovarian vascular pedicle sign revealed relative enlargement of the ipsilateral gonadal vein at that level and below to the ovarian pedicle. The maximal outer diameter of the gonadal veins at the same level in the subserosal uterine myomas ranged from 2 to 19 mm (mean, 6 mm). The mean diameter of the ipsilateral ovarian veins in ovarian tumors is larger than that of the contralateral ovarian veins and that of the ovarian vein in the subserosal uterine myomas. However, the mean diameter of the ovarian veins for differentiating ovarian masses from subserosal uterine myomas was not statistically significant. When the ovarian vascular pedicle sign on helical CT confirmed the ovarian origin, the sensitivity, specificity, positive and negative predictive values, and diagnostic accuracy were 92% (99/108), 87% (20/23), 97% (99/102), 69% (20/29), and 91% (119/131), respectively.

Discussion

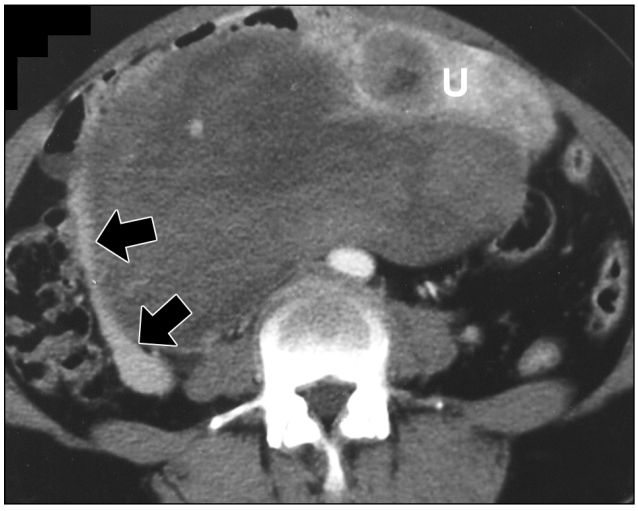
With the increasing size of a pelvic mass, doubt may still exist as to the uterine versus the ovarian origin of the mass because sometimes various juxtauterine masses including subserosal uterine myomas, adnexal masses, bowel masses, and other pelvic masses may appear similar [1]. Depiction of those masses on imaging depends on the imaging characteristics of the masses, such as their content, architecture, pattern of degeneration of the uterine myomas, and the relationship of the uterine serosa to the mass [2]. The central location and inseparability from the uterus generally allow one to make a confident diagnosis of uterine myoma. However, occasionally, pedunculated myoma, even lying within the leaves of the broad ligament, may simulate an adnexal mass [1]. Especially huge cystic pedunculated myomas of the uterus can closely resemble malignant cystic ovarian tumors [3]. The detection of a normal ovary may be a valuable clue in excluding the possibility of ovarian tumors, but normal ovaries may not be visible on imaging in postmenopausal women. Moreover, a mass may originate from the periphery of the ovary, and, therefore, identification of a normal-appearing ovary does not necessarily exclude the ovarian origin of the mass [4].

Accurate detection and differentiation of pelvic masses is important for planning a treatment strategy. The choice of modality depends on the information required, equipment available, expertise of the radiologist, and preference [5]. The usefulness of sonography in the diagnosis of pelvic tumors is well established. Sonography is the preferred method for the initial evaluation of pelvic masses for the narrow differential diagnosis of pelvic tumor. On sonography, nondegenerating uterine myomas

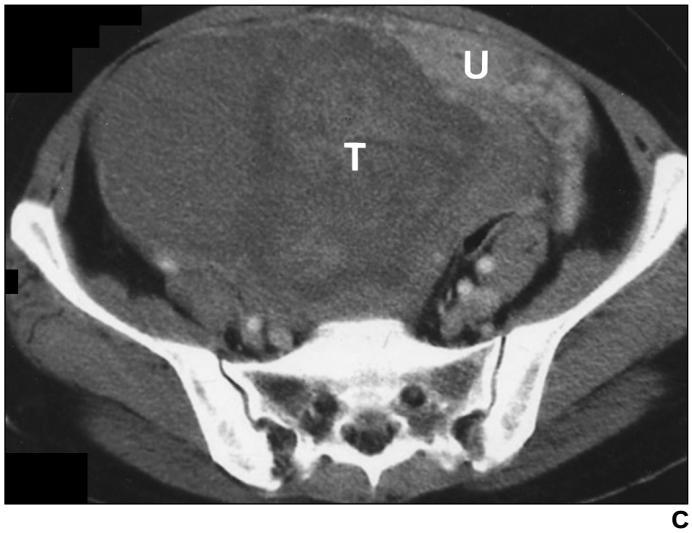
Fig. 2.—51-year-old woman with degenerated pedunculated subserosal uterine myoma. Axial single-detector helical CT was performed at different levels. U = uterine corpus.
A–C, CT scans show asymmetrically enlarged right gonadal vein (*arrow*, **A**), right gonadal vein merging into right side of tumor (*arrows*, **B**), and large tumor (T) inseparable from uterine corpus (**C**).



A



B



C

usually appear as homogeneous hypoechoic masses with poor sonic transmission, but they may show heterogeneity or decreased echogenicity if degenerated [6–8]. Transvaginal sonography is often helpful in defining the organ of origin of a pelvic mass. However, transvaginal sonography has a limitation for revealing a large mass, in which the ovary could be displaced remotely, or for showing a mass high in the pelvis with a relatively narrow field of view [1, 9].

CT is the most commonly performed study for lesion detection and differentiation, as well as for evaluation of the extent of an ovarian tumor and recurrence and response after treatment. Conventional axial CT images occasionally cannot detect the organ of origin of a pelvic tumor because ovarian masses may be located anywhere in the pelvis or lower abdomen and are most frequently found in the adnexa and the cul-de-sac or over the sacral promontory. Ovarian cancers may also abut or actually invade the uterine serosa and obscure the intervening parauterine fat plane [10].

MR imaging is usually chosen as the method for detecting the organ of origin of a pelvic mass. MR imaging is a better modality for problem-solving when sonography or CT findings are nondiagnostic or equivocal. On MR imaging, nondegenerating uterine myomas show entirely or predominantly low signal intensity on T2-weighted images, and the signal intensities of nondegenerating uterine myoma and adnexal masses may be sufficiently distinctive to permit a differential diagnosis. But degenerated uterine myoma may have varied appearances on T2-weighted and contrast-enhanced images according to the hyaline or myxoid degeneration, degree of interstitial edema, cystic degeneration, necrosis, fibrosis, calcification, hemorrhage, carneous degeneration, and fat [11]. However, some adnexal masses, such as fibroma, thecoma, Brenner tumors, dysgerminoma, and Krukenberg's tumor, can show hypointensity on T2-weighted images [12–16].

A few helpful signs for differentiating exophytic subserosal uterine myomas from adnexal or extrauterine tumors can be seen in earlier reports. Kim et al. [4] reported "interface vessels" on color and power Doppler sonography and MR imaging when feeding vessels were seen between the uterus and a pelvic mass and concluded that observation of the interface vessels seems to be a useful clue for differentiating subserosal uterine myomas from extrauterine tumors. Mittl et al. [17] reported a high-signal-intensity rim surrounding intramural and subserosal uterine myomas on T2-weighted MR images and found that histologic examination revealed markedly dilated lymphatic vessels, dilated veins, edema, or a combination of those features. The investigators mentioned that this sign may be helpful in differentiating exophytic subserosal uterine myomas from adnexal masses. Torashima et al. [18] reported that peripheral flow voids occasionally seen in leiomyoma on MR imaging correspond to dilated feeding arteries located outside the capsule of the leiomyoma and that the peripheral flow voids indicate that the uterus is the organ of origin of these pelvic

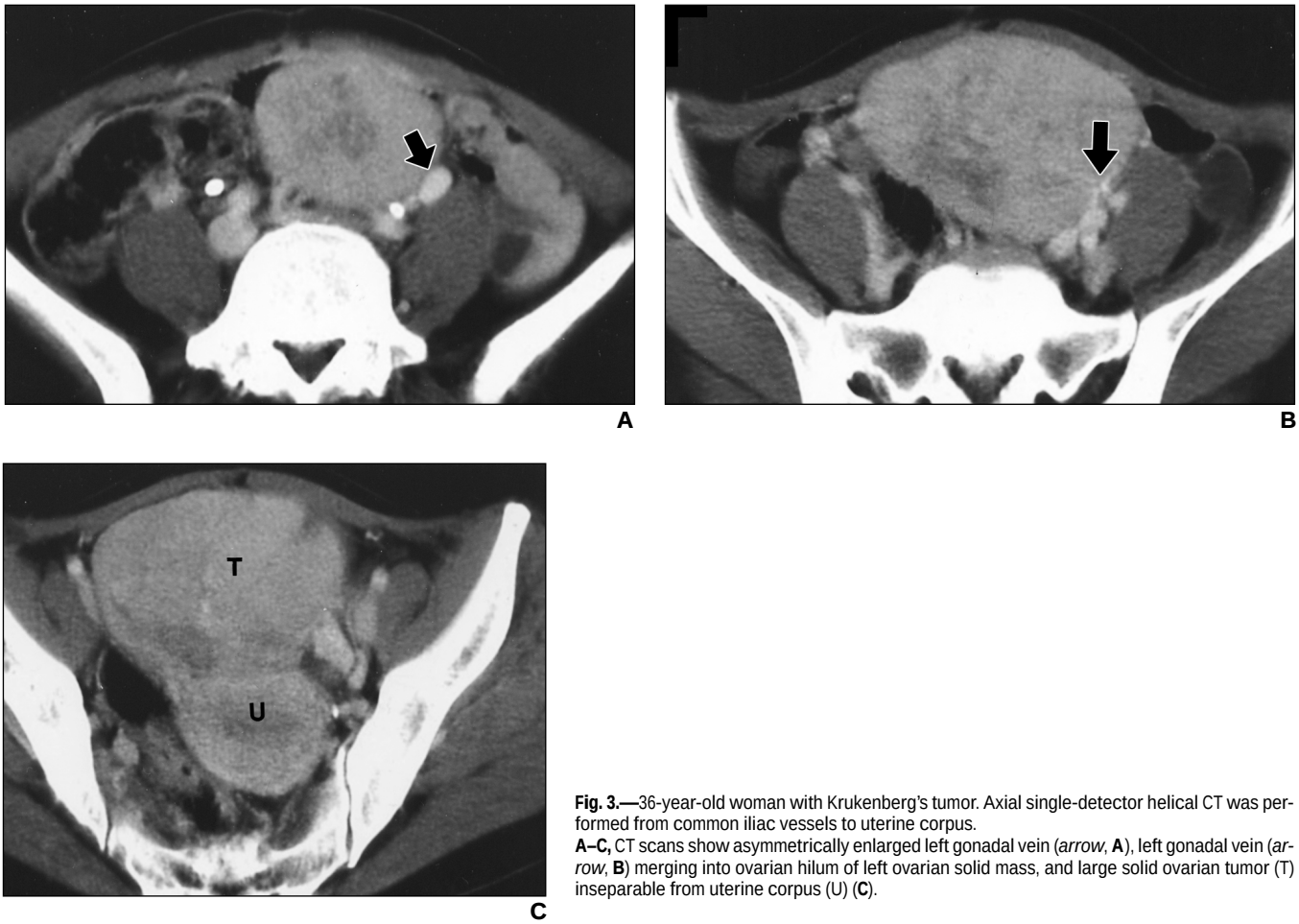


Fig. 3.—36-year-old woman with Krukenberg's tumor. Axial single-detector helical CT was performed from common iliac vessels to uterine corpus.
A–C, CT scans show asymmetrically enlarged left gonadal vein (*arrow*, **A**), left gonadal vein (*arrow*, **B**) merging into ovarian hilum of left ovarian solid mass, and large solid ovarian tumor (T) inseparable from uterine corpus (U) (**C**).

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masses because the peripheral flow voids were not seen in any other kinds of pelvic tumors.

To our knowledge, no reports have been published in the literature about any signs revealed on CT that confirm the ovary as the organ of origin of pelvic masses. The ovary is mainly supplied with the ovarian artery and drains into the gonadal vein. The ovarian vascular pedicle anatomically comprises the ovarian vessels exiting and entering the ovary with branches communicating with branches of the uterine vessels. The gonadal veins form a plexus in the broad ligament and communicate with the uterine plexus. If an ovarian mass is present, the ipsilateral ovarian vessels may be enlarged. Unlike conventional CT, helical CT allows contiguous volumetric data acquisition within a single breath-hold, thus eliminating the problem of volume-averaging artifacts. The advantages of helical CT with improved spatial resolution and optimization of contrast enhancement and thin section enable the gonadal vessel to be contiguously traced to the ovaries along axial images. Depiction of a direct joining of the normal or asymmetrically enlarged gonadal vein to the pelvic mass would indicate the ovary as the organ of origin of the mass. The ovarian vascular pedicle sign can be defined when the gonadal veins directly join the pelvic mass.

In our study, the ovarian vascular pedicle sign was identified in 92% (99/108) of the ovarian masses and in 13% (3/23) of the subserosal uterine myomas. The sign was statistically significant ($p < 0.01$) in differentiating a mass of ovarian origin from one of subserosal uterine origin. The sign was identified in 92% (22/24) of predominantly solid ovarian masses and was statistically significant in differentiating them from subserosal uterine myomas ($p < 0.01$). When teratomas that could be confirmed on CT because of their characteristic fat attenuation were excluded from our study, there was a positive sign in 95% (86/91) of the remaining ovarian masses.

The maximal outer diameter of the ovarian vein at the level of the aortic bifurcation in the ovarian tumors ranged from 2 to 13 mm (mean, 9 mm) on the ipsilateral side and from 4 to 14 mm (mean, 5 mm) on the contralateral side. The maximal outer diameter of the ovarian vein in the uterine subserosal myomas ranged from 2 to 19 mm (mean, 6 mm). The mean diameter of the ipsilateral ovarian vein in ovarian tumors is larger than that of the contralateral ovarian vein in ovarian tumors and that of the ovarian vein in the subserosal uterine myomas. However, the mean diameter for differentiating a mass of ovarian origin from one of subserosal uterine origin was not statistically significant. A 69%

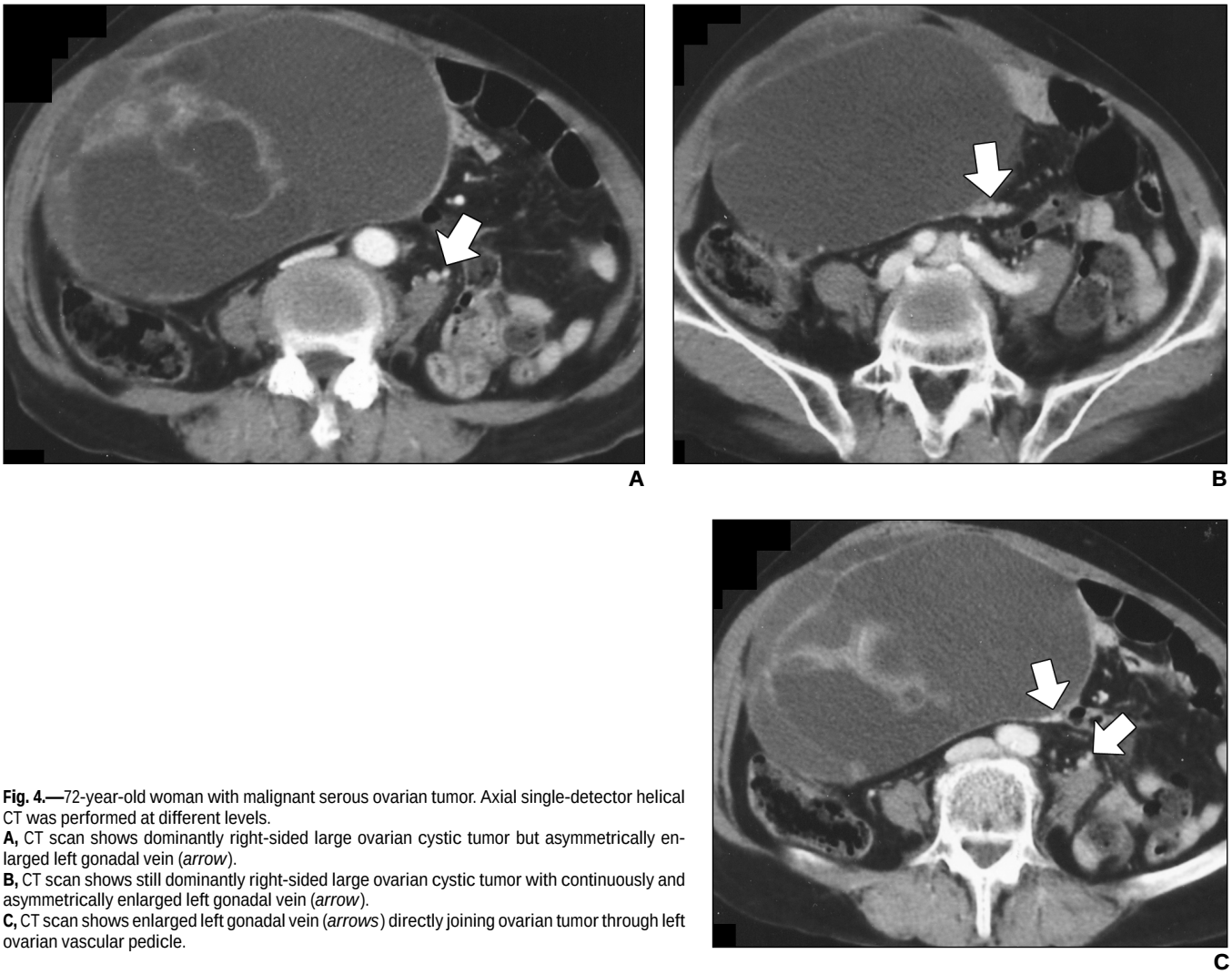


Fig. 4.—72-year-old woman with malignant serous ovarian tumor. Axial single-detector helical CT was performed at different levels.
A, CT scan shows dominantly right-sided large ovarian cystic tumor but asymmetrically enlarged left gonadal vein (*arrow*).
B, CT scan shows still dominantly right-sided large ovarian cystic tumor with continuously and asymmetrically enlarged left gonadal vein (*arrow*).
C, CT scan shows enlarged left gonadal vein (*arrows*) directly joining ovarian tumor through left ovarian vascular pedicle.

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negative predictive value may suggest that if the ovarian vascular pedicle sign is not seen, it may not be enough to ascribe the origin of the mass to the uterus. Subserosal uterine myomas with a false-positive result in our study were large, measuring more than 20 cm, and, therefore, highly hypervascular. These false-positive signs can be explained by their anatomic base with the ovarian veins communicating with the uterine veins in the broad ligament, thus forming collateral circulation. The draining veins of subserosal uterine myomas can be engorged on either side or on one side of the uterine and ovarian veins because of the dual supply of the uterus.

Our examinations were performed using a single-detector helical CT scanner. If using multidetector CT provides strongly improved *z*-axis resolution and improved quality of two-dimensional multiplanar reconstruction for the longitudinal trace of the gonadal vein, we believe that better results will be yielded for detecting the ovarian vascular pedicle sign and confirming the ovarian origin of a pelvic mass and differentiating that mass from subserosal uterine myoma.

We experienced three cases of a one-sided ovarian mass with an opposite-sided ovarian pedicle sign on helical CT, which proved to have originated from an opposite-sided ovary. The ovarian vascular pedicle sign can help to correctly determine whether the origin of the ovarian mass is the right or left ovary (Fig. 4).

We also found additional information about the ovarian vascular pedicle and ovarian hilum in the detection of torsion of an ovarian mass by the ovarian vascular pedicle sign. We had four cases of ovarian masses with surgicopathologically confirmed adnexal torsion with hemorrhagic infarction. We found a disruption of continuity of ovarian pedicular enhancement with that of the ovarian tumor wall in three of these cases (Fig. 5). This finding indicated a twisted edematous and ischemic area in the ovarian hilum, which connects the lesion with the ovarian pedicle. To date, to our knowledge, no articles have appeared in the literature reporting this finding [19, 20]. This would be the most direct sign dealing with the ovarian vascular pedicle and ovarian hilum.

We presented the findings of the ovarian vascular pedicle sign as a way of differentiating ovarian from subserosal uterine lesions on helical CT that, to our knowledge, has not been reported. In our study, the ovarian vascular pedicle sign for differentiating a mass of ovarian origin from one of subserosal uterine origin and for differentiating predominantly solid ovarian masses from subserosal uterine myomas was statistically significant. In conclusion, we consider the ovarian vascular pedicle sign on helical CT to be a useful clue in confirming the ovarian origin of a pelvic mass and for differentiating that mass from subserosal uterine myoma.

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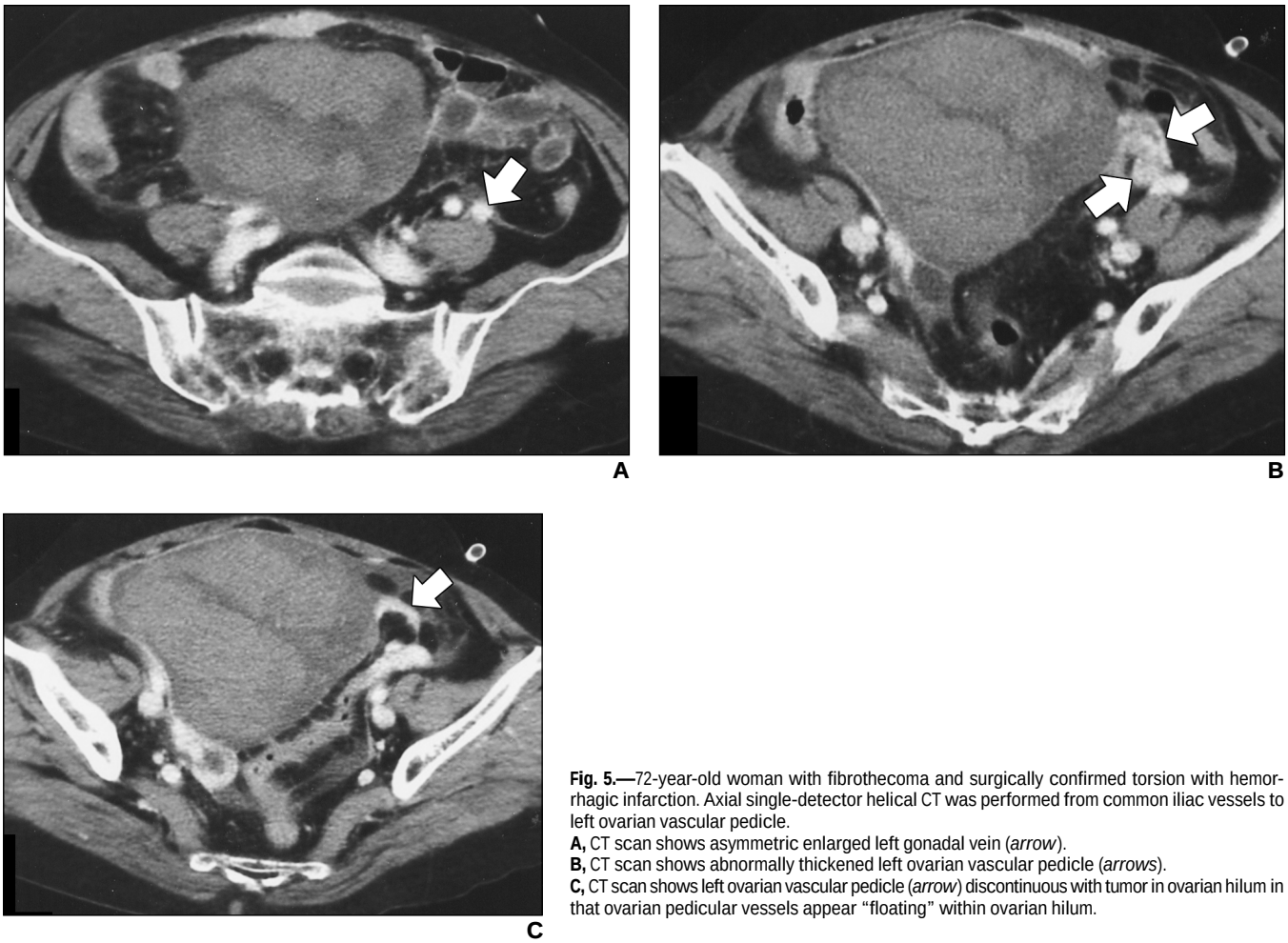


Fig. 5.—72-year-old woman with fibrothecoma and surgically confirmed torsion with hemorrhagic infarction. Axial single-detector helical CT was performed from common iliac vessels to left ovarian vascular pedicle.
A, CT scan shows asymmetric enlarged left gonadal vein (*arrow*).
B, CT scan shows abnormally thickened left ovarian vascular pedicle (*arrows*).
C, CT scan shows left ovarian vascular pedicle (*arrow*) discontinuous with tumor in ovarian hilum in that ovarian pedicular vessels appear "floating" within ovarian hilum.

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