Ovarian masses in young adolescents: imaging findings with surgical confirmation

V.T. Skiadas[1], V. Koutoulidis[1], M. Eleytheriades[2], A. Gouliamos[1], L.A. Moulopoulos[1] E. Deligeoroglou[2], L. Vlachos[1], G. Kreatsas[2]

[1]Department of Radiology, [2]2nd Department of Obstetrics and Gynecology, University of Athens, Aretaieion Hospital, Athens (Greece)

Summary

Functional cysts and benign neoplasms are the most common ovarian masses among young adolescents. Ovarian cancer on the other hand, although rare in this age group, is the most common genital tract malignancy. The purpose of this study was to define imaging characteristics of ovarian masses in adolescents between 12 and 21 years old and correlate imaging and surgical findings.

Thirty-seven female adolescent patients aged between 12 and 21 years were operated on because of a diagnosed ovarian mass between 1997 and 2002. All patients underwent pelvic ultrasound, five had an abdominal CT scan, two had abdominal MRI, one abdominal X-ray and one intravenous pyelography. Ultrasound was used to define the size of the lesion and to characterize its gross morphologic condition as solid, simple cyst or complex cyst. The records were reviewed for age at presentation, presenting symptoms, diagnostic studies, surgical procedure and pathology findings, which were available for all patients.

In our study 32 patients (86.5%) were symptomatic and five asymptomatic (13.5%). The most common presenting symptom was abdominal pain (59.5%). Thirty-four patients (91.1%) had benign lesions, two had malignant tumors (5.4%) and one patient had a borderline lesion (2.7%). The most common ovarian masses detected were germ cell tumors (27,5%) and functional cysts (25%). Twenty patients (54%) underwent operative laparoscopy and 17 patients (46%) exploratory laparotomy. Simple resection of the ovarian mass was achieved in the majority of cases (84%). Bilateral salpingo-oophorectomy was performed in only one case (2.7%).

Key words: Ovarian mass; Adolescents; Ultrasound; Magnetic resonance imaging; Computed tomography.

Introduction

Benign neoplasms and functional cysts are the most common ovarian masses among the pediatric age group. Although ovarian cancer is rare, accounting for 1-2% of all malignancies in children and adolescents, it is however the most common genital tract malignancy in this age group [1].

The preoperative diagnostic work-up of an adolescent with an ovarian mass includes pelvic and rectal clinical examination, pelvic ultrasound (US), intravenous pyelography (IVP) and an evaluation of the hormonal status and serum tumor markers. Barium enema and chest radiography may contribute to the estimation of the extent of disease. If clinical and imaging findings suggest an inflammatory or neoplastic lesion, computed tomography (CT) or magnetic resonance imaging (MRI) may provide further critical information for the nature and origin of the pelvic mass. Ovarian surgery must not serve as the primary tool in the diagnosis of ovarian masses since, on the one hand it negatively affects fertility and on the other hand ovarian malignancy accounts for a small percentage of all adnexal masses. A thorough diagnostic work-up, as described above, is therefore necessary in order to decide for the proper therapeutic management of the patient.

The purpose of this study was to define imaging characteristics of ovarian masses in adolescents between 12 and 21 years old and correlate imaging and surgical findings.

Revised manuscript accepted for publication September 16, 2003

Materials and Methods

From 1997 to 2002, 37 female adolescent patients aged between 12-21 years (median age = 18.56) were operated on because of a diagnosed ovarian mass at the 2nd Department of Obstetrics and Gynecology, University of Athens. All patients were referred to the Department of Radiology, University of Athens, Aretaieion Hospital, for a preoperative pelvic ultrasound. One patient was premenarchal and 36 were postmenarchal. All patients underwent pelvic ultrasound, five of them abdominal CT, two abdominal MRI, one abdominal X-ray and one IVP.

The records were reviewed for age at presentation, presenting symptoms, diagnostic studies, surgical procedure, and pathology findings, which were available for all patients. For purposes of further analysis, pathologic diagnoses were divided into the following six categories: (a) ovarian functional cyst, (b) endometrioma, (c) paraovarian cyst, (d) epithelial neoplasm, (e) germ cell neoplasm and (f) sex cord-stromal neoplasm. Type of operative approach in relation to the type of the lesion was recorded. US was used to define the size of the lesion (determined by the largest diameter) and to characterize its gross morphologic condition as solid, simple cyst or complex cyst.

Statistical analysis was performed using SPSS 10.0 (SPSS Inc., Chicago, IL). Mean values are reported with the standard deviation (SD). Statistical significance was set at $p \leq 0.05$.

Results

The study included 37 patients between the ages of 12 and 21 years (median age = 18.56). Age distribution of the adnexal masses is presented in Table 1. One patient was premenarchal and 36 were postmenarchal.

Table 1. — *Age distribution of the lesions.*

	Patient age	
	Mean age (years)	Range
Functional cyst	18 (13-21)	2.60
Epithelial neoplasm	16.5 (13-20)	3.11
Sex cord stromal tumor	18 (14-20)	2.63
Germ cell tumor	20 (16-21)	2.35
Endometrioid cyst	19 (12-21)	3.60
Paraovarian cyst	18.5 (16-21)	1.95

Thirty-two patients (86.5%) were symptomatic and five asymptomatic (13.5%). The most common presenting symptom among our patients was abdominal pain, occurring in 59.5% (22 of 37). Seven patients presented with menstrual disorders (18.9%) and three more patients were referred to our department for abdominal swelling, palpable abdominal tenderness and fever, respectively (2.7% each) (Table 2).

Table 3 shows ultrasound findings according to the characterization and the size of the lesion. Computed tomography was performed on five patients with very large masses (110 to 170 mm) for better delineation of the lesion. The mean size of these lesions was 134.6 mm. In one case, an additional ultrasound finding of a uterus bicornis led to an MRI examination for further detailed evaluation. MRI findings were a uterus didelphys with the right horn dilatated, due to a diaphragm in the ipsilateral vagina and a normal left horn with hypoplastic vagina. Chest X-ray was performed as part of the preoperative diagnostic work-up of the patients. It was negative in all but one patient with an immature mixed teratoma, where multiple metastases were identified in both lungs.

The pathologic findings are tabulated in Table 4. Thirty-four patients (91.1%, p = 0.91) had benign lesions, two had malignant tumors (5.4%, p = 0.054) and one patient had a borderline lesion (2.7%, p = 0.027). The most common adnexal mass was a germ cell tumor (11 out of 40) accounting for 27.5% (p = 0.275). Nine of these tumors were benign lesions and two were malignant. The second most common lesion was a functional cyst (follicular or corpus luteum) representing 25% of all lesions (p = 0.25). Endometriomas constituted 15% (6 out of 40), paraovarian cysts 12.5% (5 out of 40), sex cord stromal tumors another 10% (4 out of 40) and epithelial neoplasms 10% (4 out of 40). Table 2 shows the mean patient age at presentation in relation to each histologic type. The maximum median age corresponds to germ cell tumors (20.22 years, SD = ± 2.49) and the minimum to epithelial neoplasms (16.5 years, SD = ± 3.11).

Table 2. — *Presenting symptoms of the patients.*

Presenting sympton	n (%)
Abdominal pain	22 (59.5)
Menstrual disorders	7 (18.9)
Abdominal distension	1 (2.7)
Palpable mass	1 (2.7)
Fever	1 (2.7)
Incidental findings	5 (13.5)
Total	37

Table 3. — *Correlation between pathologic and US findings.*

Pathologic finding	US findings				
	Simple (%)	Complex (%)	Solid (%)	Lesion size	
				Mean size (cm)	SD
Paraovarian cyst	100			76.60	35.66
Germ cell tumor		100		71.10	23.90
Epithelial tumor	75	25		106.00	50.00
Sex cord stromal tumor		50	50	91.00	50.47
Functional cyst					
A. Functional	75		25	96.75	12.53
B. Corpus luteum		100		56.00	8.91
Endometrioid		83.3	16.7	72.40	32.84

Table 4. — *The pathological findings in our series.*

Pathology findings	n (%)	p value
Functional cysts:	10 (25)	0.25
1. Follicular	4 (10)	0.10
2. Corpus luteum	6 (15)	0.15
Endometrioid cysts	6 (15)	0.15
Paraovarian cysts	5 (12.5)	0.125
Epithelial:		
A. Benign		
1. Serous cystadenomas	3 (7.5)	0.075
2. Mucinous cystadenomas	1 (2.5)	0.025
B. Malignant	–	–
Sex cord stromal:	4 (10)	0.10
1. Fibroma	3 (7.5)	0.075
2. Sertoli-Leydig (low malignant potential)	1 (2.5)	0.025
Germ cell:	11 (27.5)	0.275
1. Benign mature teratoma	9 (22.5)	0.275
2. Malignant teratoma	2 (5)	0.05
Total	40*	

*Three patients had bilateral lesions.

All operations were performed by a gynecologist and all were scheduled as nonemergent procedures. Twenty patients (54%) underwent operative laparoscopy. Resection of the adnexal mass was achieved in all cases. In addition lysis of adhesions was performed in one case and biopsy of the contralateral ovary in another. In 17 patients (46%) exploratory laparotomy was considered the appropriate surgical technique. Simple resection of the ovarian mass was performed in 11 cases (29.7%), oophorectomy in one case (2.7%), unilateral salpingo-oophorectomy in four (10.8%) and bilateral salpingo-oophorectomy in one case (2.7%).

Discussion

Adolescents constitute a very small fraction (approximately 6%) of women with ovarian masses [2] and an even smaller one, if only ovarian malignancies are taken into account. According to various authors, non-neoplastic lesions constitute the vast majority (57.9 - 98%) of adnexal masses in this age group [3-6]. In our series, non-neoplastic adnexal masses represented 52.5%, benign neoplastic lesions 40% and malignancies 5% of all operated adnexal lesions. One case (2.5%) was characterized as an ovarian tumor of borderline malignancy. Our study group constituted operated-on cases only, which explains the relatively small percentage of non-neoplastic lesions.

Functional ovarian cysts (follicular or corpus luteum) are common abnormal ovarian lesions. The unaccomplished ovulation leads to a follicular cyst that continues to grow and presents as an ovarian mass. The corpus luteum forms from a ruptured follicle and produces progesterone. If it remains active for more than two weeks (luteal phase) or if excess bleeding takes place in side it, it appears as an adnexal mass and may cause abnormal uterine bleeding, due to the ongoing production of progesterone. In that case pain is the major symptom. In many series functional cysts represent a substantial percentage of non-neoplastic ovarian lesions [7]. Although the majority of these cysts resolve with or without oral contraceptives [4, 8, 9] a small number (because of persistence of the mass) will be operated on. In our study functional cysts that required an operative approach constituted 25% of all masses and 47.6% of non-neoplastic lesions (10 out of 21). Six out of ten functional cysts in our study were removed with exploratory laparotomy and the rest by operative laparoscopy.

Sonography is more specific in the diagnosis of a follicular cyst than a corpus luteum cyst [6]. Follicular cysts are usually simple cysts (in our study 3 out of 4 follicular cysts were simple cysts and one appeared as a solid mass) in contrast to the corpus luteum cysts which are often complex and lead to a wider differential diagnosis (100% of the corpus luteum cysts in our series were complex masses). Hemorrhage in a functional cyst can lead to a diagnostic dilemma. Sonographically they appear solid or complex. Follow-up ultrasound imaging helps to clarify the diagnosis and prevents an unnecessary operation [6].

Two types of endometriosis have been described: diffused and localized (also known as endometrioma or chocolate cyst). Endometrioma is a hemorrhagic mass that is caused by active endometriosis of the ovary. On imaging studies it usually appears as a well-defined unilocular or multilocular predominantly cystic mass with internal echoes [1]. Occasionally a fluid-fluid level can be seen due to blood degradation products. Although it is rarely found in adolescents, in contrast to diffuse endometriosis [10, 11], it represents 15% of all ovarian lesions in our study (Table 4). This is a result of the small likelihood to resolve after therapy with oral contraceptive pills. Sonographically it resembles a corpus luteum cyst (88.3% of endometriomas had the same echogenicity with corpus luteum cysts) although in our study they were significantly larger (Table 3). Four of them were removed under operative laparoscopy and two with exploratory laparotomy.

Paraovarian or paratubal cysts can be identified in the adnexal region and can mimic any other cystic ovarian lesion. They are found in the broad ligament and are usually of mesothelial or paramesonephric origin and rarely of mesonephric origin [12]. They are purely cystic lesions, vary in size and can easily be confused with functional cysts. Patients are often asymptomatic and they can be followed up with ultrasound, which in these cases shows no changes in lesion size or echogenicity throughout the menstrual cycle. Nevertheless, they usually require surgical intervention and they are less likely to resolve with or without medication. In our study they represented 12.5% of all lesions (Table 4), were all purely cystic, and had a mean size of 76.6 mm (from 47 to 130 mm) (Table 3).

Ovarian neoplasms occur in 2% to 25% of adolescents with adnexal masses, with the majority of them being germ cell tumors [4, 6, 13, 14]. Epithelial neoplasms and sex cord stromal tumors follow in descending order of frequency.

Germ cell tumors are derived from the primitive germ cells of the embryonic gonad. They account for the majority of all neoplastic adnexal lesions in that age. In our study they consisted of 27.5% of all masses and 57.7% of neoplastic lesions. Nine were dermoid cysts, one was a grade 1 malignant immature teratoma and one was a grade 3 malignant mixed germ cell tumor.

Dermoid cysts are composed of well-differentiated tissues originating from the endoderm, mesoderm and ectoderm. The variable sonographic appearance ranges from hyperechoic to completely anechoic. Certain ultrasound features that are considered specific have been described, such as the "dermoid plug" (an echogenic mural nodule containing teeth, hair and fat) (Figure 1), the "tip of the iceberg" sign (an echogenic mass obscuring the posterior wall of the lesion) and the "dermoid mesh" (multiple echogenic linear interfaces in the lesion, which have been shown to be hair fibers). In our study five out of nine cases had one or more of the above sonographic features, thus suggesting a likely diagnosis of dermoid cyst preoperatively. At CT the presence of fluid, fat and calcifications in an adnexal mass is virtually diagnostic of an ovarian dermoid (Figure 2).

The mean age of patients with dermoid cysts was 19.8 years (from 16 to 21) with a mean size of 61 mm (SD = ± 12.32). They were all complex masses and contained calcified elements that caused shadowing (15). The reported bilaterality of dermoid cysts in that age group is

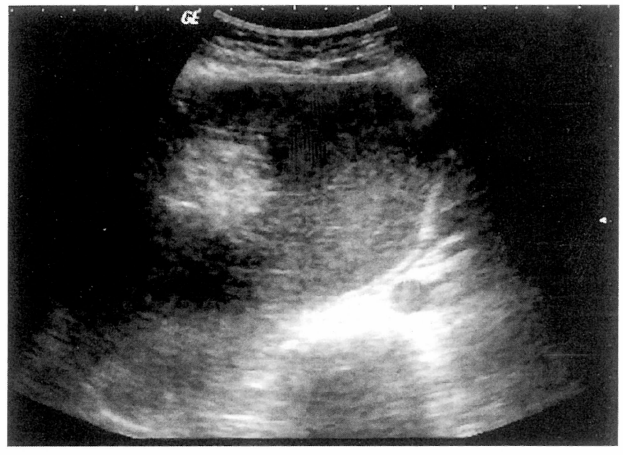

Figure 1. — Dermoid cyst in a 21-year-old woman. Transabdominal axial US scan shows a predominantly cystic mass with a solid echogenic mural nodule casting an ill-defined acoustic shadow ("dermoid plug").

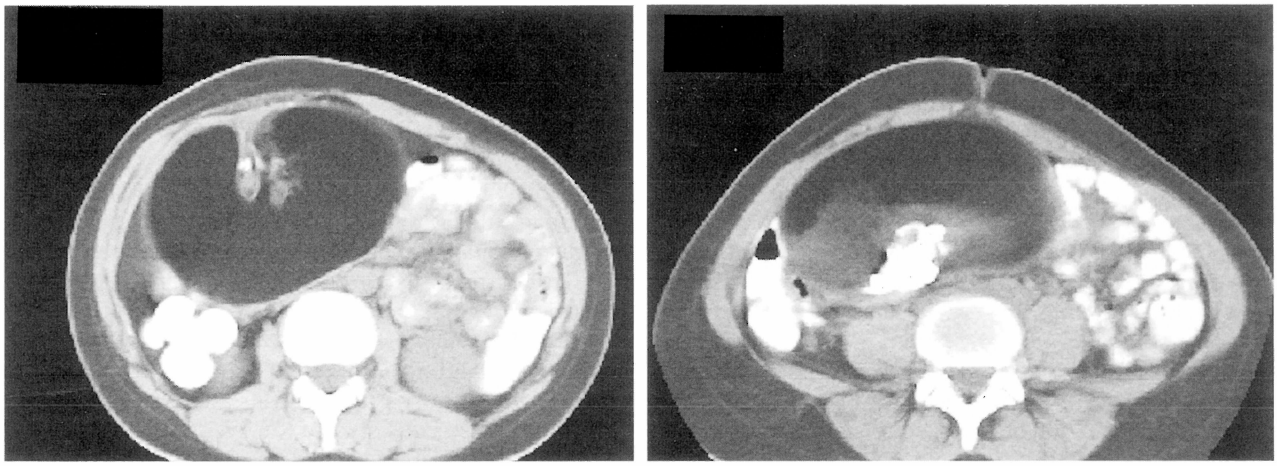

Figure 2. — Dermoid cyst in a 17-year-old girl.
(a) Non-enhanced CT scan demonstrates a large 12-cm mass composed primarily of fat in the right anterior lower abdomen. There is a small tissue component arising from the anterior aspect of the mass with a small calcification in it.
(b) At a lower level extensive calcification is seen within a large soft tissue component in the predominantly fatty mass.

5%-9%. In our study bilateral mature teratomas were identified in one case (11.1%). Seven dermoid cysts were removed under operative laparoscopy and two with exploratory laparotomy.

Immature teratomas in our study were both complex masses on ultrasound with cystic and solid components. The first patient was 20 years old and a grade 1 germ cell malignancy of the right ovary was identified. The lesion had the greatest diameter of 11 cm and was removed under laparotomy along with a corpus luteum cyst, incidentally discovered in the left ovary. CT identified no lymphadenopathy or distant metastases. The second patient was 19 years old and presented with abdominal pain. Ultrasound examination depicted a complex pelvic mass with a greatest diameter of 12 cm. Bilateral lung metastases and left paraaortic lymphadenopathy were detected by CT. A grade 3 mixed germ cell tumor (grade 3 immature teratoma, endodermal sinus tumor and dysgerminoma) was identified after the operation. After postoperative chemotherapy and three and six months of imaging follow-up, the patient showed complete regression of lung metastases and decrease of the paraaortic lymphadenopathy.

Epithelial neoplasms are the second most common ovarian neoplastic mass in adolescents and increase in incidence with age [1]. Serous cystadenomas and cystadenocarcinomas are more common than mucinous cystadenomas and cystadenocarcinomas, respectively, and rarely appear bilaterally. Sonographically they appear as unilocular large masses that may have thin internal septations and/or multiple papillary projections from the cyst wall. Mucinous cystadenomas or cystadenocarcinomas may have low-level echoes caused by the mucoid material. The rate of malignancy in these tumors ranges from 7.5% to 30% [16, 17]. Epithelial neoplasms made up 10% of all masses in our study; three were serous cystadenomas and one was a mucinous cystadenoma. The average age was 16.5 years (from 13 to 20) and mean size 106 mm with a wide range (57 mm to 170 mm). No epithelial malignancy was detected in our study and all lesions were unilateral.

Sonographically three out of four were purely cystic and one was cystic with the presence of thin internal septations (Table 3). Two of the tumors were removed laparoscopically and the rest, due to their size (120 mm and 170 mm) under laparotomy.

Sex cord-stromal tumors are statistically the third most common group of neoplastic ovarian masses in adolescents. They include granulosa-theca cell tumors, fibromas, thecomas, Sertoli-Leydig cell tumors and undifferentiated sex cord-stromal tumors. They can be endocrinologically active causing precocious puberty, abnormal uterine bleeding or amenorrhea due to estrogen production. Sertoli-Leydig tumors may develop estrogenic or androgenic effects. Fibromas and thecomas are always benign and Sertoli-Leydig and granulosa-theca cell tumors rarely are malignant. They are all usually unilateral and limited to the ovary [17, 18]. In our study three of all the lesions were fibromas and one a Sertoli-Leydig cell tumor of intermediate differentiation.

Fibromas arise from the ovarian stroma. They are benign, usually unilateral and rarely show clinical signs of estrogen production. The majority of patients are asymptomatic which often allows the mass to reach a large size before detection. The typical sonographic finding is that of a hypoechoic mass with posterior attenuation, although various appearances have been noted due to the tendency of these tumors for cystic degeneration. In our study fibromas represented 7.5% of all kind of adnexal lesions that were operated on. The age of appearance ranged from 14 to 19 (mean age 16.6 years) and their size between 30 and 150 mm (mean size = 91 mm). Their sonographic appearances were solid (2 cases) with the typical features described above or complex (1 case). The latter was an 8 cm right adnexal lesion with a large central cystic portion with internal echoes. Due to

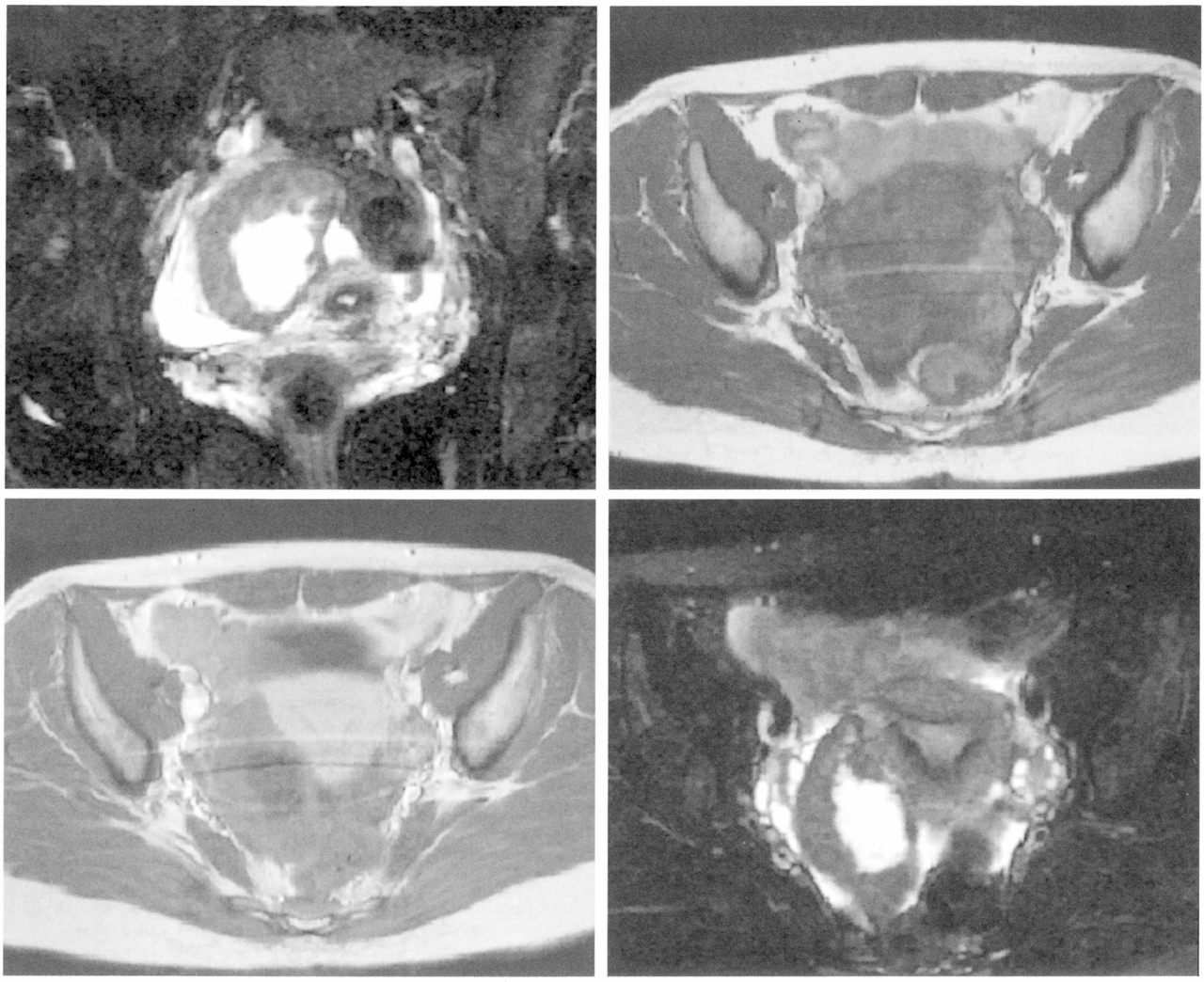

Figure 3. — Fibroma in an 18-year-old girl.
(a) Coronal T2-weighted MR image (repetition time msec/echo time msec = 2500/80) shows an 8-cm well-defined mass lying lateral to the uterus and medial to the right ovary. It has a low-signal-intensity solid part and a central cystic component.
(b, c) On axial T1-weighted (500/14) and gadolinium-enhanced axial T1-weighted (500/14) MR images the solid portion of the mass again demonstrates low-signal-intensity and slightly enhances following contrast administration.
(d) Axial T2-weighted MR image (2500/80) demonstrates well the mixed nature of the mass and its relationship to the urinary bladder and rectum.

the atypical appearance MRI was performed and revealed low T1 and T2 signal intensity of the solid component of the tumor (Figure 3). A preoperative diagnosis of fibrous ovarian tumor with cystic degeneration was proposed and was confirmed surgically. Two out of three were removed with laparotomy and the third due to its small size (3 cm) under operative laparoscopy.

Sertoli-Leydig tumors commonly produce masculinization or at least defeminization, but a few have estrogenic effects [1]. They are unilateral and occur in women of all ages, although the peak incidence is in the second and third decades. Sonographically they vary from small to very large masses. Small lesions are predominantly solid and the larger ones are multiloculated with cystic components. In our case the tumor was detected in an 18-year-old woman presenting with intermenstrual bleeding. Ultrasound showed a 9 x 9 x 8 cm complex mass and CT revealed intense inhomogeneous enhancement of the lesion with hypodense areas, probably representing necrosis and cystic degeneration. Pathologic and immunohistochemical examination revealed a Sertoli-Leydig tumor of intermediate differentiation (Figure 4).

Controversy exists regarding the selection of tumors that can be removed by laparoscopy, because of concerns about an adverse effect on prognosis with malignant tumors. At this point preoperative ultrasonography is very helpful for a detailed assessment of an adnexal mass. Sonolucent lesions with thin walls and no solid components are at a very low risk for malignancy and therefore are suitable for laparoscopic removal. In our study the size of the lesion – although it cannot help in differentiating between benign and malignant lesions due to sig-

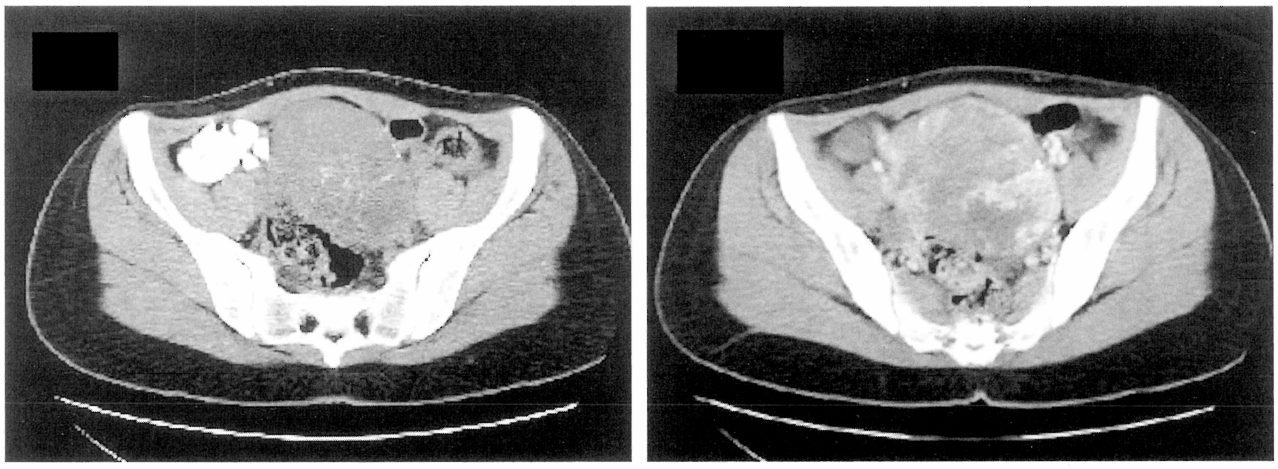

Figure 4. — Sertoli-Leydig cell tumor in an 18-year-old girl.
(a) Non-enhanced CT scan shows a 9-cm ovoid pelvic mass with scattered internal and peripheral calcifications.
(b) Contrast-enhanced CT scan demonstrates the complex nature of the mass with enhancement of solid tissue elements and a thick, irregular wall.

nificant overlap – was taken into account in selecting the type of operation. Generally there was a conservative operating approach in order to avoid infertility problems. The ovary was completely removed in only four cases. A detected ovarian mass in a young adolescent comprises a social problem for the patients and their families. Our study reveals that, even if the lesion does not regress spontaneously or after the proper medication and the patient is led to the operating room, the vast majority of these masses are benign. In this respect both the radiologist and the referring physician can be quite reassuring to the patient and relatives for the outcome.

References

[1] Pfeifer S.M., Gosman G.G.: "Evaluation of adnexal masses in adolescents". *Pediatr. Clin. No. Am.*, 1999, *46* (3), 573.
[2] Yakushiji M., Matsukuma T., Abe M. *et al.*: "Ovarian tumors in adolescents less than 20 years of age". *Acta Obstet. Gynecol. Jpn.*, 1981, *33,* 833.
[3] Tepleman C., Fallat M.E., Blinchensky A., Hertweck S.P.: "Non-inflammatory ovarian masses in girls and young women". *Obstet. Gynecol.*, 2000, *96*, 229.
[4] Kanizsai B., Orley J., Szigetvari I. *et al.*: "Ovarian cysts in children and adolescents: Their occurrence, behavior, and management". *J. Pediatr. Adolesc. Gynecol.*, 1998, *11,* 85.
[5] Warner B.W., Kuhn J.C., Barr L.L.: "Conservative management of large ovarian cysts in children: The value of serial pelvic ultrasonography". *Surgery,* 1992, *112,* 749.
[6] Wu A., Siegel M.J.: "Sonography of pelvic masses in children: Diagnostic predictability". *Am. J. Roentgenol.,* 1987, *148*, 1199.
[7] Van Winter J.T., Simmons P.S., Podratz K.C.: "Surgically treated adnexal masses in infancy, childhood, and adolescence". *Am. J. Obstet. Gynecol.*, 1994, *170,* 1780
[8] Steinkampf M.P., Hammond K.R., Blackwell R.E. *et al.*: "Hormonal treatment of functional ovarian cysts: A randomized, prospective study". *Fertil. Steril.,* 1990, *54,* 775.
[9] Egarter C., Putz M., Strohmer H. et al.: "Ovarian function during low-dose oral contraceptive use". *Contraception,* 1995, *51,* 329.
[10] Chatman D.L., Ward A.B.: "Endometriosis in adolescents". *J. Reprod. Med.*, 1982, *27,* 156.
[11] Goldstein D.P., deCholnoky C., Emans S.J., Leventhal J.M.: "Laparoscopy in the diagnosis and management of pelvic pain in adolescents". *J. Reprod. Med.,* 1980, *24*, 251.
[12] Athey P.A., Cooper N.B.: "Sonographic features of paraovarian cysts". *Am. J. Roentgenol.,* 1985, *144*, 483
[13] Nelson L., Ekbom A., Gerdin E.: "Ovarian cancer in young women in Sweden, 1989-1991". *Gynecol. Oncol.,* 1999, *74,* 472.
[14] Thind C.R., Carty H.M., Pilling D.W.: "The role of ultrasound in the management of ovarian masses in children". *Clin. Radiol.,* 1989, *40,* 180.
[15] Teele R.L., Share J.C.: "Ultrasonography of the female pelvis in childhood and adolescence". *Radiol. Clin. No. Am.*, 1992, *30,* 743.
[16] Deprest J., Moerman P., Corneillie P., Ide P.: "Ovarian borderline mucinous tumor in a premenarchal girl: Review on ovarian epithelial cancer in young girls". *Gynecol. Oncol.,* 1992, *45,* 219.
[17] Gershenson D.M., Del Junco G., Herson J., Rutledge F.N.: "Endodermal sinus tumor of the ovary: The M. D. Anderson experience". *Obstet. Gynecol.*, 1983, *61,* 194.
[18] Lack E.E., Young R.H., Scully R.E.: "Pathology of ovarian neoplasms in childhood and adolescence". *Pathol. Ann.*, 1992, *27,* 281.

Address reprint requests to:
S. VASSILIOS, M.D.
Kanari 42
14341 Nea Philadelphia
Athens (Greece)