CT Findings of Ovarian Teratomas:
Mature versus Immature

Jong Chul Kim, M.D., Young Wol Kim, M.D.

Purpose: To differentiate mature and immature ovarian teratomas, using CT findings.

Materials and Methods: The CT findings of ten mature ovarian teratomas (in one patient, bilateral) and ten which were immature were compared, using statistical analysis. Images were evaluated for size, margins, architecture, contents (mural nodules, fat, calcification), septa, local invasion and distant metastasis. These findings were compared with pathologic findings.

Results: Of the ten mature tumors, nine were well defined and predominantly cystic in internal architecture, and one was mixed. Mural nodules were found in six tumors, fat in all, distinct calcification in seven, and regular septa in three lesions. Of the ten immature tumors, eight had irregular margins. Seven were predominantly solid in internal architecture and irregularly enhanced, two were mixed, and one was mainly cystic. Fat was detected in five lesions, indistinct scattered calcification in six, irregular septa in three, and local invasion or distant metastasis in four patients.

Conclusion: Compared with mature ovarian teratomas, those that are immature tend to show CT findings of marginal irregularity, solid mass with irregular enhancement, scattered indistinct calcifications, septal irregularity, local invasion or distant metastasis. Our experience suggests that these findings may be helpful in differentiation of mature and immature ovarian teratomas.

Index Words: Ovary, neoplasms
Ovary, CT
Teratoma

In patients aged less than 21, the majority of ovarian tumors are of germ cell origin, and of these more than 40% are malignant. Of many kinds of germ cell tumors, only mature teratomas, which are almost always cystic, are benign (1). Teratomas are benign or malignant neoplasms that are derived from primordial germ cells and can arise in the gonads or in extragonadal locations. They are most common in the sacrococcygeal region, while the ovary is the next most frequent primary site (2, 3).

Mature cystic teratomas make up approximately 25% of all ovarian neoplasms, and are usually treated by surgical resection (4). Immature teratomas are treated surgically and with multiagent chemotherapy. It is important to distinguish a benign mature teratoma from one that is immature, since due to the frequent invasion of surrounding structures the latter cannot be completely excised (5).

Ultrasonography is useful in detecting ovarian teratomas, but typical sonographic features are found in less than 50% of lesions (6, 7). CT findings characteristic of teratomas (i.e. fat or fat and calcification) have been reported in 65% of lesions (8, 9). There have, however, been only a few reports which differentiate mature and immature teratomas on CT findings (10).

The purpose of this study is to differentiate mature and immature ovarian teratomas, using CT findings.

MATERIALS and METHODS

The CT findings of nine patients with mature ovarian
teratomas (in one case, bilateral) and ten with those which were immature were retrospectively reviewed and compared. Between 1984 and 1996, all 20 teratomas were surgically resected and pathologically proven. The age of the patients ranged from two months to 32 years (mean, 16 years). In addition to CT findings, tumor markers [serum α-fetoprotein (FP) and human chorionic gonadotropin (HCG)] in each patient were also reviewed.

CT was performed with a GE 8800 or GE Advantage High Speed (General Electric Medical Systems, Milwaukee, Wisconsin, USA); continuous precontrast and postcontrast scans from the symphysis pubis to the iliac crest were obtained at 8 or 10mm intervals, with 5 mm slice thickness, during shallow breathing or suspended expiration.

Images were evaluated for the (1) size, (2) margins (smooth, well defined versus irregular, ill defined), (3) internal architecture (cystic, solid, or mixed, according to the percentage of low attenuation or soft tissue components), (4) contents (mural nodules, fat, the shape and location of calcifications), (5) septa in multilocular mass (regular, even, thin septum of less than 3mm in thickness versus irregular, uneven, thick septum of more than 3mm in thickness), (6) local invasion, and (7) distant metastasis. Low attenuation cystic components were defined as areas having CT attenuation values ranging from 10 to 20 Hounsfield units, whereas soft tissue components had densities equal to muscle densities. Based on internal consistency, tumors were classified as cystic (less than 10% soft tissue components of whole tumor volume), solid (more than 50% soft tissue components), and mixed (10—50% soft tissue components). Local invasion on CT was based on the presence of tumor infiltration into the fat planes around the mass or encasement of vessels. Findings related to the above radiologic criteria were analyzed by two radiologists, who reached a consensus.

CT and pathologic findings were compared. The chi-square test and Fisher’s exact test were used to evaluate the significance of CT findings in the differential diagnosis of mature and immature ovarian teratomas.

RESULTS

Mature teratomas were found in patients aged between 15 to 32 years (mean, 22), while immature teratomas were found in those aged between two months and 14 years (mean, 10 years). Thus patients with mature ovarian teratomas were older than those with immature tumors \((p=0.0002)\). Five of ten immature teratomas (50%) had elevated \(\alpha\)-FP levels, but, all mature teratomas had normal levels of tumor markers.

The comparative CT findings of mature and immature ovarian teratomas are summarized in Table 1. Their largest diameters ranged from 3.5 to 20 cm; even though the mean diameter of immature teratomas was greater than that of mature teratomas, there was no statistically significant difference in size between mature and immature lesions. Tumor margins were smooth and well defined in eleven lesions (Fig. 1, 2, 3), and irregular and ill defined in nine (Fig. 4). Nine tumors (81.8%) with smooth margins were mature and two (18.2%)}
Fig. 2. Contrast enhanced CT scan of a mature cystic teratoma. CT scan through the upper pelvis demonstrates a well defined cystic mass with multiple mural nodules in the posterior wall (arrows) in the right side of the pelvis. The CT number of the inner homogeneous hypodense content was \(-40\) H.U. Pathologic specimen revealed a dermoid cyst containing sebaceous fluid and hairs in the right ovary.

Fig. 3. Contrast enhanced CT scan of a benign mature teratoma. CT scan through the mid-pelvis demonstrates a well defined, multilocular cystic mass with calcification in a mural nodule in the posterior wall, mulberry shaped solid portions attached to the left lateral wall (white arrow), and hypodense fatty content in the left side of the pelvic cavity. The inner septa are linear, thin, and regular in thickness (black arrowheads). Pathologic examination revealed a left ovarian mature teratoma composed of sebum, calcification and hair.

Fig. 4. Contrast enhanced CT scans of a large multilocular immature teratoma.

a. CT scan through the mid-pelvis shows a large multilocular cystic and solid mass with somewhat irregular posterior margin, occupying the entire pelvis. It contains multiple irregularly enhanced solid portions, some scattered small calcific foci (arrowheads), and several tiny hypodense fatty areas. The septa are thick and irregular.

b. CT scan at a lower level demonstrates a multiseptated cystic and solid mass with hypodense fat, and irregularly enhanced soft tissue scattered through the posterior two thirds portions of the mass. The margins of this mass were irregular except the anterior cystic portion. The resected specimen showed a large immature teratoma of multilocular mixed nature in the right ovary with immature elements, tiny cyst, fat and calcifications. Pathology revealed extragenital local soft tissue invasion of this grade 1 immature teratoma.

% were immature. Eight tumors (88.9%) with irregular margins were immature and one was mature \((p=0.0054)\).

A cystic mass with predominantly fluid and less than 10% soft tissue content was seen in ten of 20 cases (50%) \((p=0.0054)\); a predominantly solid mass with more than 50% soft tissue content was seen in seven of 20 cases (35%). Six of these seven lesions had more than 90% soft tissue content \((p=0.001)\). A complex mixed mass with 10-50% soft tissue content was seen in three of 20 cases \((15\%)\); the soft tissue content was 40% in one mature lesion \((p=0.001)\), and 45-50% in two immature lesions \((p=0.001)\). Nine cystic lesions and one mixed lesion were mature. All seven solid soft tissue lesions were immature \((p=0.001)\). Mural nodules containing soft tissue, fat or calcifi-
califications were seen only in six mature teratomas (Fig. 1–3) \((p=0.044)\). Fifteen of 20 lesions (75\%) contained areas of fat on CT; these fatty areas accounted for most of the tumor content in three cases (Fig. 2), appeared as small irregular foci in ten cases (Fig. 1, 4, 5, 6a), and as fat-fluid level in two. Of these lesions, ten were mature and five were immature. Calcifications were detected by CT in 13 of 20 cases (65\%) i.e. seven mature teratomas and six which were immature. The shape of calcifications was distinct with sharp margins in six of seven mature tumors (85.7\%), and small and indistinct in four of six immature tumors (66.7\%) \((p=0.053)\). Calcifications in dermoid cysts were located in mural nodules (Fig. 1, 3), while calcifications in immature teratomas were scattered throughout the tumors (Fig. 4, 6a).

Seven of 20 tumors (35\%) were multilocular lesions with multiple septa (Fig. 1, 4, 6a). All septa in three mature multilocular tumors were regular (Fig. 1), but the septa in three of four immature tumors (75\%) were irregular (Fig. 4, 6a) \((p=0.143)\). Local infiltration and distant metastases were seen in four of ten immature tumors (40\%) (Fig. 6).

In all patients, CT findings correlated relatively well with gross pathologic findings.

**DISCUSSION**

Teratomas are classified histologically into mature (benign), immature (malignant), and monodermal or highly specialized (struma ovarii and carcinoid) types (11, 12).

The mature teratoma is a benign tumor composed of tissues foreign to the anatomic site in which they arise and usually contains tissues from at least two germ cell layers. In 90\% of cases, tissues from all three germ cell layers are seen (6). Benign mature teratomas are either cystic or solid. Mature cystic teratomas, usually known as dermoid cysts, make up 20-25\% of all ovarian neoplasms (4, 11), and 95\% of ovarian germ cell tumors (13). Unlike other germ cell tumors, they can be encountered at any age (4). The cystic component is usually a greasy liquid, composed of keratin, sebum, and hair surrounded by a firm capsule of varying thickness. This tumor is usually unilocular (11), but may be multilocular, divided by septa into a number of compartments (14). The mature solid teratoma has a predominantly solid gross appearance (11, 15), but multiple small cystic areas are also present. These rare neoplasms occur in young women, predominantly in the second decade (11). The prognosis is excellent, even if peritoneal implants are present (16). Mature teratomas may have undergone malignant transformation. The most common malignant change in a mature cystic teratoma is squamous cell carcinoma, followed by carcinoma and adenocarcinoma (11).

The immature teratoma is composed of a mixture of embryonal and adult tissue derived from all three germ cell layers (11). They are usually predominantly solid, but numerous cysts of varying size are also seen, and occasionally they can be entirely cystic (1). They occur most commonly in children and young adults (4, 13)
who are on average aged 11 years (17). The prognosis depends a great deal on the nature and amount of embryonal component especially of primitive neuroectoderm (18). They are typically not associated with elevated serum HCG levels (19), but in a review of the recent literature, 50% of these tumors had elevated αFP levels (20). In our study, five of ten immature teratomas (50%) had elevated αFP levels.

Mature teratomas are usually treated by surgical resection (4), and immature teratomas are treated surgically and with multiagent chemotherapy (5, 21, 22). Due to the frequent invasion of surrounding structures, immature teratomas frequently cannot be completely excised (6). There has been some suggestion that immature teratomas recur more frequently than mature teratomas and that recurrent tumors are more likely to be malignant (6). It is therefore considered important that mature and immature teratomas are preoperatively distinguished on CT.

In our study, mature and immature teratomas were not significantly different in size. Mass size was not, therefore, a reliable indicator of whether a tumor was mature or immature.

In our study, tumor margins tend to be smooth and regular in mature teratomas (90%), and irregular and ill-defined in immature tumors (80%) (p=0.00548). Tumor margin may thus be a helpful indicator in the differentiation of mature and immature tumors.

Most of mature teratomas in our study (90%) were cystic; the one exception was both cystic and solid. On pathologic study, cystic contents were found to be either serous or sebaceous. With contrast media injection, most of immature teratomas (70%) were seen to be irregularly enhanced (p=0.001). Immature teratomas tend to be more solid than those that are mature. It may be difficult to differentiate a benign solid teratoma from an immature teratoma, though, fortunately, mature solid teratomas are rare (11).

In our study, mural nodules were found on CT only in mature teratomas (six of 20) (p=0.044), similar to the result of Quillin et al. (10). Within the ovarian dermoid cyst, there may be a protuberance arising from its wall and projecting into its cavity. It is composed of a small nodule or a round, elevated mass, and soft tissue prominence may be single or multiple. It has been called Rokitansky’s protuberance, dermoid nipple, dermoid protuberance, or dermoid mamilla (11). The presence of mural nodules favors the diagnosis of mature ovarian dermoid cyst.

In 75% of the cases in our study, tumors were seen on CT to contain fatty components, an incidence similar to that of Friedman et al. (9), but lower than the figures of 93-96% found by Buy et al (8). Even though, in our study, fat was more frequently detected in mature lesions (100%) than in immature lesions (50%), the percentage of fat in a tumor was not a useful indicator whether a teratoma was mature or immature.

In our study, calcifications (teeth, spiculate, amorphous, punctate, etc.) were found with similar frequency in both mature and immature tumors. Calcifications were, though, more indistinct and smaller in immature than mature tumors (p=0.053). Calcifications of dermo-

Fig. 6. Contrast enhanced CT scans of an immature teratoma.

a. CT scan through the upper abdomen demonstrates an ill defined, huge, solid mass with multiple irregularly enhanced soft tissue areas, scattered high densities suggesting indistinct calcifications (arrowheads), several foci of hypodense fatty tissues and curvilinear irregular septa (arrows). Pathologic specimen revealed an immature teratoma of grade III in the right ovary, containing numerous primitive neuroepithelial elements, fat, calcifications, bone, cartilage, multiple small cysts and septa.

b. CT scan through the mid-pelvis shows irregularly enhanced, dirty, curvilinear densities in the mesentery (arrows). These findings are compatible with tumor infiltration into mesentery. The operative findings revealed multiple, fine, irregular infiltrative nodules in broad ligament, mesentery, peritoneum, posterior of the uterus, and sigmoid mesocolon. The pathologic examination confirmed tumor infiltration into all these areas.
id cysts were located in mural nodules in five of six cases (83.3%), while calcifications in immature teratomas were scattered throughout the tumors (100%). Friedman et al. (9) reported calcification and teeth in the dermoid plug on CT. Calcifications can be seen in immature teratomas because of the almost invariable association with mature teratomas. Although calcifications may, in the former, represent teeth, they are more commonly fragments of calcified cartilage or bone (1), and can therefore be more irregular in these teratomas. The location and morphology of calcifications may be helpful in the differentiation of mature and immature tumors.

The mature tumor is usually unilocular but may be multilocular, divided by septa into a number of compartments (13). Rosai (11) reported that 88% of his cases were unilocular. Benign teratomas in our study were unilocular in 70% of cases. Septa in the tumors were found in seven of 20 cases, without a significant difference in incidence between mature and immature tumors. In immature teratomas, however, the septa were more irregular in thickness and shape and more strongly enhanced (three of four cases) than those which were mature (none of three) \((P=0.143)\), though the difference was not statistically significant.

In our study, tumor margin, internal architecture and the mural nodule were found to be very helpful in the differentiation of mature and immature ovarian teratomas.

In conclusion, immature ovarian teratomas tend to show CT findings of marginal irregularity, solid mass with irregular enhancement, septal irregularity, tiny indistinct and scattered calcifications, local invasion or distant metastasis, compared with mature teratomas. Even though these findings are not determinant, they may be helpful in the differentiation of an immature and immature ovarian teratoma, especially when they are considered in conjunction with serum \(\alpha\)-FP level and the patient age.

REFERENCES

5. Sisler CL, Siegel MJ. Ovarian teratomas: a comparison of the sonographic appearance in prepubertal and postpubertal girls. AJR 1990; 154: 139-141
난소 기형종의 CT 소견: 성숙형과 미숙형의 감별

김종철·김영월

목 적: 성숙형과 미숙형의 난소 기형종을 CT 소견으로 감별하고자 함.

대상 및 방법: 성숙형 10예(1명은 양측성)와 미숙형 10예의 난소 기형종의 CT 소견을 종양의 크기, 윤곽, 내부 구조, 성분(지방, 석회화, 벽 결절), 격막, 국소 침습과 원격 전이에 대해 분석한 후, 병리 소견과 비교하였다.

결과: 성숙형 종양 10예 중 9예의 윤곽이 염확하였다. 내부 구조로 볼 때 9예는 낭성 종괴였고, 한 예는 혼합 종괴이었다. 벽 결절은 6예, 지방은 10예, 두 통하여 석회화는 7예, 그리고 규칙적인 격막은 3예에서 관찰되었다. 미숙형 종양 10예 중 8예의 윤곽이 불규칙하였다. 내부 구조로 볼 때 불규칙하게 조영 증강되는 고형 종괴가 7예, 혼합형이 2예, 그리고 낭성 종괴가 1예이었다. 지방은 5예, 산재된 석회화는 6예, 불규칙한 격막이 3예, 국소 침습과 원격 전이가 4예에서 보였다.

결론: 성숙형에 비해 미숙형 난소 기형종은 CT상 그 윤곽 및 격막이 덜 불규칙하고, 불규칙하게 조영 증강되는 고형 성분이 많고, 석회화가 불분명하게 산재되어 있으며, 국소 침습이나 원격 전이도 많다. 이상의 소견은 난소의 성숙형과 미숙형 기형종을 감별하는 데 도움을 줄 수 있을 것으로 사료된다.
《저작권에 관한 동의서》

라든 제목의 논문이 대한방사선의학회지에 출간될 경우 그 저작권을 대한방사선의학회에 이전한다. 저자는 저작권이외의 모든 권한 즉, 특허신청이나 향후 논문을 작성하는 등의 권한은 소유한다. 저자는 대한방사선의학회지로부터 서면허가를 받으면 타논문에 본논문의 자료를 사용할 수 있으며 이 경우 자료가 발표된 원논문을 밝힌다. 본논문의 모든 저자는 본논문에 실질적이고 지적인 공헌을 하였으며 논문의 내용에 대하여 공적인 책임을 공유한다.
본논문은 과거에 출판된 적이 없으며 현재 타학술지에 제출되었거나 제출할 계획이 없다.

제 1저자/ 년 월 일
제 2저자
제 3저자

제 4저자
제 5저자
제 6저자

[ 분 야 : ]
본 동의서는 원고에 기술된 순서대로 전 저자의 서명이 있어야 함.

대한방사선의학회 원고 최종 점검표

☐ 원고 1부, 사진 1부를 동봉한다.
☐ 행간 여백 1행 (double space)에 21×30cm (A4) 용지에 작성한다.
☐ 원고배열은 한글과 영문으로 기재된 표지, 내표지, 초록 (한글과 영문), 서론, 대상 및 방법, 결과, 고찰, 참고문헌, 표, 사진설명의 순으로 한다.
☐ 초록은 목적, 대상 및 방법, 결과, 결론으로 나누어 기술한다.
☐ 영문초록 하단에 색인단어 (Index Words) 를 기입한다.
☐ 저작권에 관한 동의서에 전 저자가 서명한다.
☐ 투고규정내의 저자 점검사항을 점검하였다.