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Duplex Transvaginal Ultrasonographic Images of Gestational Trophoblastic Tumors in Clinical Practice

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ABSTRACT

Objective To assess the special characteristic of intrauterine and adnexal lesions of Gestational Trophoblastic Tumors (GTT) visualized by Duplex Transvaginal Ultrasonography and the benefits and pitfalls of ultrasound images in clinical practice.

Design A prospective descriptive study.

Setting Rajvithi Hospital.

Subjects and methods Forty one GTT patients, classified as low, medium and high risk using WHO Scoring System for Gestational Trophoblastic Tumors, were examined by Duplex Transvaginal Ultrasonography prior to be administration of chemotherapy. The characteristic of lesions, tumoral blood flow and resistant index (RI) were recorded.

Result The intrauterine and adnexal lesions demonstrated by Duplex Transvaginal Ultrasonography had the unique patterns of the lesions and blood flows and could be used in making diagnosis in conjunction with human Chorionic Gonadotrophic hormone (hCG). However, intrauterine and adnexal lesions were unable to depict 10 in 25 patients in low risk cases and 2 in13 high risk cases that had only few high impedance flows at peripheral parts of the lesions. There were no statistic differences in resistant indexes between low, medium and high risk.

Conclusion Duplex Transvaginal Ultrasonography is non-invasive and economic procedure. When it is used in conjunction with hCG, it effectively depicts the intrauterine and adnexal lesions of GTT, which is characterized by the prominence of low impedance flows and is very helpful in clinical staging and planning the treatment of GTT.

Key words: gestational trophoblastic tumors, Duplex Ultrasound, transvaginal ultrasound

Gestation Trophoblastic Tumour (GTT) comprises invasive mole and choriocarcinoma.[1] Incidence is estimated as form 1:10,000 to 1:70,000 pregnancies in Western countries and 1:250 to 1:6,000 in Asia.[2] The true extent of geographic variation is difficult to ascertain. Some of the best Asian data from Singapore reported an incidence of 1:4,298 live births.[2] Since the development of effective chemotherapy and sensitive assays for hCG; GTT has become one of the most readily curable of human malignancies.

GTT is diagnosed by abnormal regression of serum human hCG following molar pregnancy evacuation, a histopathologic diagnosis of invasive mole, choriocarcinoma, or demonstration of metastases in conjunction with an elevated hCG following any pregnancy event. Once the presence of a trophoblas-

tic tumour has been diagnosed, it is necessary to d etermine the extent of the disease. At Rajavithi Hospital, patients are categorized as low risk, medium risk and high risk according to the World Health Organisation (WHO) Scoring System for Gestational Trophoblastic Tumour.[1] Individualization of chemotherapy is initiated. Duplex Transvaginal Ultrasonography is non-invasive, economical and well-accepted by the patients. It has been used in the detection of intramyometrial lesions and promises good potential.[3-5] The purpose of the studies was to assess the special characteristic of intrauterine and adnexal lesions of GTT visualized by B-scan and color Doppler images and to evaluate the benefits as well as pitfalls in clinical uses.

Materials and Methods

Forty-one GTT patients seen at the Rajavithi Hospital between 1991-1995 were accessed by Duplex transvaginal ultrasonography prior to chemotherapy administration. Patients underwent a metastatic survey including: chest X-ray, ultrasound of liver, CT scan or MRI of brain in lung metastatic patients, complete blood count with differential, platelet count, serum chemistries including liver and renal function studies, and quantitative serum hCG. The uterine and adnexal lesions were examined by Duplex transvaginal ultrasonography prior to and during chemotherapy administration.

The instrument used for duplex scan was the Aloka SSD-680 machine with 5.0-MHz curve array transvaginal probe, manufactured by Aloka Co, LTD. The spatial peak temporal average intensity was estimated to be 65 mW/cm^2. The wall filter was set at its minimum (50 Hz) and sample volume size set at 2 mm. Endovaginal sonographic image analysis focused on

1. Determination of uterine and adnexal lesions
2. Observation and documenting of B-scan images of the suspected lesions
3. Evaluation of tumour vascularity by color flow device and pulsed Doppler

Spectral waveform of intratumoral flow was depicted on all colour-coded spots. Optimum visualization of small colored blood vessels in the uterus was achieved by diminishing B-scan gain and color pulse repetition frequency. Doppler waveforms were measured using Resistant Index (RI, peak systolic flow velocity minus end-diastolic flow velocity divided by peak systolic flow velocity) as the numeric end point method. The Doppler spectrum and RI were recorded on a paper strip for subsequent analysis. The RI measurement was repeated at various colour-coded spots. The lowest RI of each patient was recruited for analysis.

Results

Patients underwent tumor survey and staging according to the WHO classification Scoring System for Gestational Trophoblastic Tumour. Twenty five were low risk, three medium risk and thirteen high risk.

Ten patients in the low risk category were not able to demonstrate neither intramyometrial lesion nor color flow (Table 1). All were asymptomatic, having persistent disease after molar pregnancy evacuation except one patient presented with posterior comissure metastatic lesion. The other fifteen low risk cases were able to demonstrate uterine lesions. Most of them were asymptomatic except two came with vaginal bleeding and all of them had persistent serum hCG level post molar pregnancy termination (table 2). Mean and median serum hCG values prior administration of chemotherapy were 9,075 and 7000 mIU/ml when compared with 834 and 275 mIU/ml in low risk with indiscernible uterine lesions (Table 1). B-scan images revealed distinctive hypo or hyperechoic lesions interspersed with multiple serpigeneous anechoic channels and spaces located adjacent to uterine cavity or embedded in myometrium (Figure 1). Nearly all of these channels demonstrated high velocity blood flow reflected by the color brightness. The color-coded spots were abundant and easily detected by the color flow device. Pulsed Doppler sampling disclosed arterial waveforms showing low impedance flow (Figure 2). In some cases, the small avascular multicystic lesion, or honeycomb appearance

surrounded by multiple small vascular spaces, were observed (Figure 3). Predominant cystic vascular spaces within uterine muscles were depicted in three cases (Figure 4). The size of spaces varied between two and five centimeters. Duplex scan revealed high velocity and turbulent flow at the periphery and within these spaces (Figure 5). Myometrial tissue adjacent to the cystic spaces demonstrated echogenic changes traversed by tiny anechoic vascular channels characterized by high flow-low impedance waveforms. Mean value of RI was 0.359.

There were only three patients in medium risk (Table 3). All were asymptomatic. The serum hCG values, the interval between evacuation of molar pregnancy and treatment, B-scan imaging and RI were not different from low risk with discernible lesion (Table 2).

Thirteen patients were staged as high risk (Table 4). All were symptomatic except case no. 94/11 who became pregnant after chemical remission of GTT post molar pregnancy. She was diagnosed by serial serum hCG and Duplex transvaginal ultrasound after sharp curettage for blighted ovum. Serum hCG was highly elevated. Lungs metastases were shown in all cases except case no. 94/11. Multiple organ metastases were noted in case no. 93/6 (lungs, brain, spleen, liver and kidneys). The average interval between pregnancy and treatment was 7.2 months. B-scan images of this group revealed enlarged uterus with inhomogeneous uterine textures. Uterine muscles were invaded by hypervascular hyperechogenic or mixed hyper-hypoechogenic lesions (Figure 6). The average lesion diameter was 6.5 centemeter. Small cystic necrotic spaces and avascular areas characterized by an absence of color flows scattering within the lesions were observed in many cases. In some cases, the avascular area covered almost the entire uterine lesion. Hysterectomy was performed and the central tissue necrosis was confirmed by histopathology (no.93/13). Intratumoral small vascular channels and/or spaces characterized by high flow and low impedance waveforms were evident at the peripheral part of avascular lesions. The color brightness was relatively less striking than those low risk cases with discernible lesions.

Not all cases demonstrated hypervascularity. The intratumoral flow could hardly be depicted in case nos. 91/2 and 93/6 and the RIs of 0.487 and 0.667 which were higher than the average (0.360). One complete invasive mole was picked up by Duplex scan right after molar pregnancy evacuation (case no. 92/10).

B-scan also disclosed large adnexal complex masses in three cases (case nos. 94/2, 95/1, 95/7). The adnexal lesions comprised mainly multi-cystic spaces intermingle with complex masses extending from the lateral uterine wall to the adnexal region (Figure 7). The lesions were highly vascular, characterized by low impedance and turbulent flow. In case no. 95/7, tumours had caused a partial obstruction of the right ureter ensuing hydroureter and hydronephrosis.

Mean RIs of low risk, medium risk and high risk were 0.359, 0.341 and 0.360. There were no statistical differences between mean RIs of these three group by Kruskal-Wallis One Way Analysis of Variance (p value = 0.7035, second degree of freedom, Kruskal-Wallis H = 0.703).

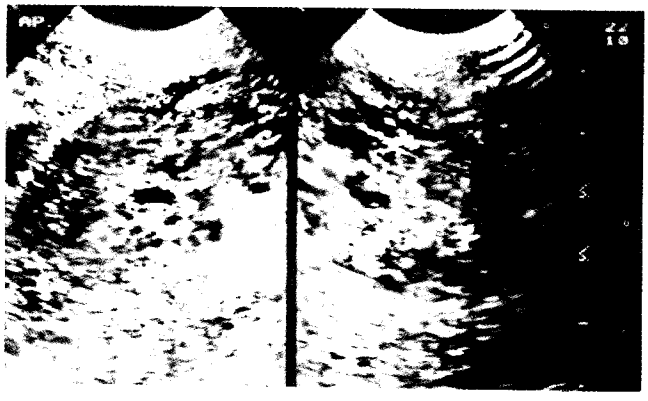


Fig. 1. Echogenic lesion interspersed with multiple serpigeneous anechoic channels and spaces.

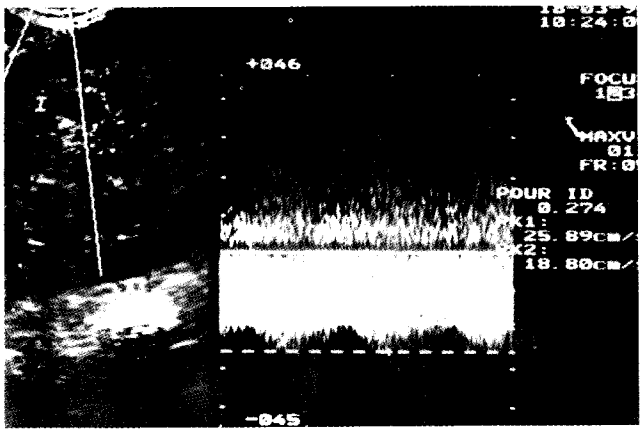


Fig. 2. Intratumoural low impedance flow.



Fig. 3. Honeycomb appearance within uterine muscle.

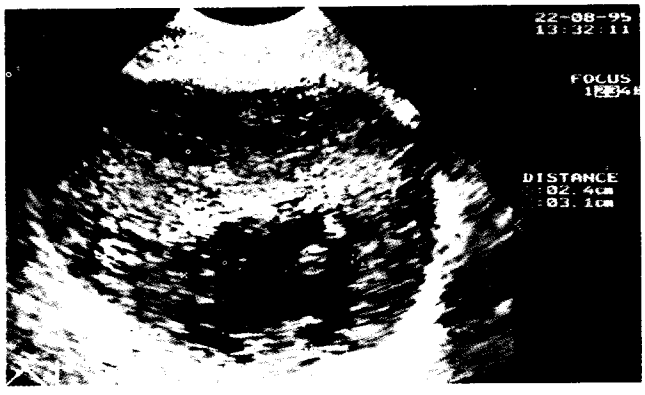


Fig. 4. Large cystic necrotic space at the posterior uterine wall.

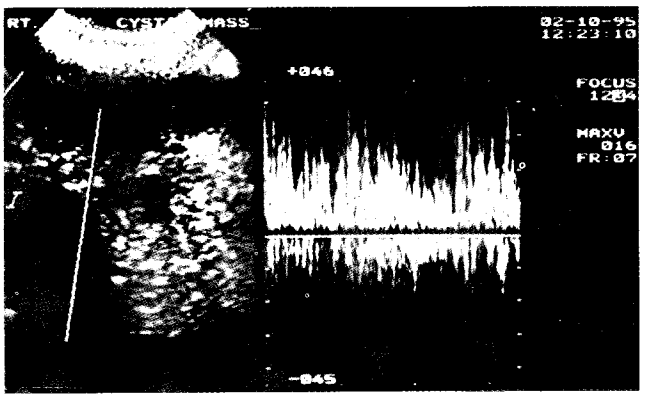


Fig. 5. Turbulent flows demonstrated within the cystic necrotic space.

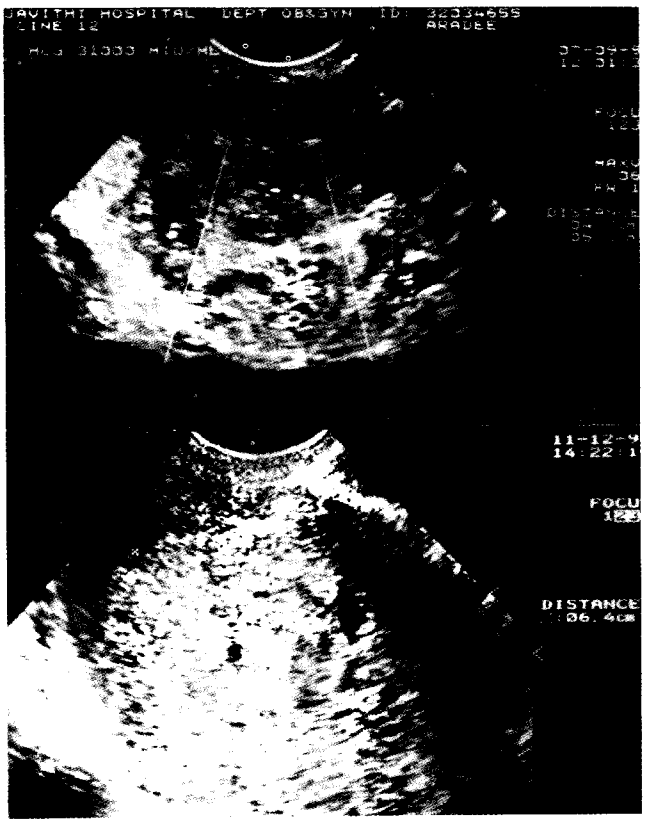


Fig. 6. Mixed hyper-hypoechogenic lesions interspersed with irregular sonolucent spaces were demonstrated on anterior and posterior uterine walls (above).

Hyperechogenic lesion, 6.4 cm.,without discernible color Doppler flow was illustrated (below), histopathology consistant with necrotic tissue.

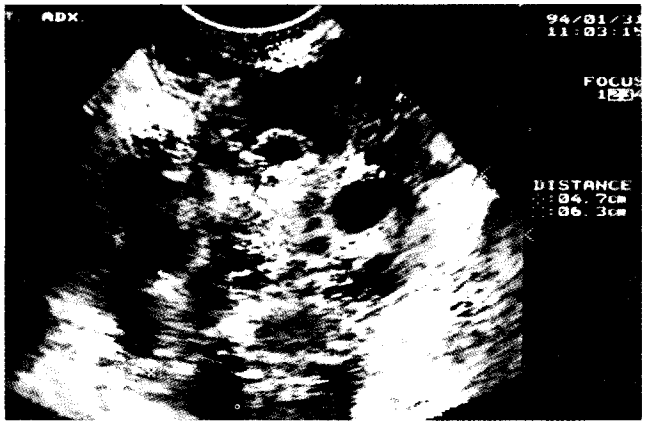


Fig 7. Complex amorphous mass, mixed soft tissue and cystic spaces at the adnexal region.

Table 1. Low risk GTT - indiscernible uterine and adnexal lesion

Case No.	Antecedent pregnancy	Risk	hCG (mIU/cc)	Interval (months)	Presenting symptoms
92/7	*HM	Low	1,630	2.0	asymptomatic
93/1	HM	Low	1,300	1.0	asymptomatic
93/3	HM	Low	2,100	3.1	asymptomatic
93/5	HM	Low	40	5.0	asymptomatic
93/8	HM	Low	18	2.0	asymptomatic
94/7	HM	Low	286	4.5	asymptomatic
94/9	HM	Low	61	4.5	asymptomatic
94/10	HM	Low	63	3.5	asymptomatic
95/3	HM	Low	2,578	2.5	posterior commissure metastases
95/5	HM	Low	265	1.5	asymptomatic

*HM = Hydatidiform mole

Serum hCG(mIU/cc.) prior treatment Mean = 834.1 (standard deviation 927.7)
Median = 275.5: Maximum = 2578: Minimum = 18

Interval(months) Duration between termination of pregnancy and diagnosis of GTT

Table 2. Low risk GTT - discernible uterine lesion

Case No.	Antecedent pregnancy	hCG mIU/cc	Interval (months)	Intra-uterine lesion(cm.)	**RI	B-scan imaging	Presenting symptoms
92/3	*HM	6,940	0.50	3.0	0.288	Echogenic	vaginal bleeding
92/4	HM	1,890	3.00	1.0	0.361	Echogenic	asymptomatic
92/5	HM	31,000	5.00	5.0	0.417	Echogenic	asymptomatic
92/8	HM	23,830	2.00	5.5	0.383	Echogenic	vaginal bleeding
93/2	HM	13,180	1.5	2.0	0.370	Cystic vascular space	asymptomatic
93/3	HM	2,250	1.75	2.0	0.313	Echogenic	asymptomatic
93/7	HM	9,392	6.0	3.0	0.370	Cystic vascular space	asymptomatic
93/10	HM	1,150	1.75	3.0	0.425	Echogenic	asymptomatic
94/1	HM	7,000	2.00	3.0	0.304	Echogenic	asymptomatic
94/3	HM	13,740	2.00	3.0	0.353	Echogenic	asymptomatic
94/5	HM	1,765	5.00	2.0	0.285	Echogenic	asymptomatic
†95/2	HM	9	7.0	2.6	0.370	Cystic vascular space	asymptomatic
95/9	HM	7,577	1.00	2.3	0.388	Echogenic	asymptomatic
95/10	HM	6,514	1.00	3.0	0.388	Echogenic	asymptomatic
95/11	HM	9,899	3.0	3.0	0.365	Cystic vascular space	asymptomatic
		Mean	2.8	2.9	0.359		
		***STDEV.	1.9	1.1	0.042		

*HM = Hydatidiform mole: **RI = Resistant Index: ***STDEV = Standard deviation

Serum hCG(mIU/cc.) prior treatment Mean = 9,075 (STDEV 8,375); Median = 7000: Maximum = 31,000: Minimum = 9

Interval(months) Duration between termination of pregnancy and diagnosis of GTT

† Patient was allowed to be followed by serum hCG despite slow regression hCG curve.

Table 3. Medium risk GTT

Case No.	Antecedent pregnancy	hCG mIU/cc	Interval (months)	Intra-uterine lesion(cm.)	**RI	B-scan imaging	Presenting symptoms
92/9	*HM	9,692	1.0	3.5	0.371	Echogenic	asymptomatic
93/11	HM	1,500	4.5	3.0	0.321	Echogenic	asymptomatic
92/2	HM	9,149	3.0	3.2	0.333	Cystic necrosis	asymptomatic

HM = Hydatidiform mole: **RI = Resistant Index

Serum hCG(mIU/cc.) prior treatment

Interval(months) Duration between termination of pregnancy and diagnosis of GTT

Table 4. High risk GTT

Case No.	Antecedent pregnancy	hCG mIU/cc	Interval (months)	Intra-uterine lesion(cm.)	**RI	B-scan imaging	Presenting symptoms
91/2	Term	>300,000	7.0	8.0	0.330	Mixed hyper-hypo echoic.	Vaginal bleeding
†92/10	*HM	200,000	0.0	6.0	0.293	Mixed hyper-hypo echoic	Hemoperitoneum, dyspnea
††93/6	HM	>400,000	8.0	5.5	0.487	Mixed hyper-hypo echoic	Headache, dyspnea
††93/13	HM	40,000	4.0	5.0	0.667	Mixed hyper-hypo echoic	Vaginal bleeding
94/6	HM	16,000,000	5.0	10.0	0.365	Mixed hyper-hypo echoic	Vaginal bleeding
94/8	Abortion	99,830	7.0	7.0	0.304	Mixed hyper-hypo echoic	Vaginal bleeding
95/12	Abortion	153,630	15.0	3.4	0.228	Mixed hyper-hypo echoic	Vaginal bleeding
95/13	Unknown	1,434,600	-	6.4	0.410	Mixed hyper-hypo echoic	Vaginal bleeding
95/14	Unknown	639,600	-	6.5	0224	Mixed hyper-hypo echoic	Vaginal bleeding
94/11	Blighted ovum	135,861	4.0	5.0	0.397	Cystic necrosis	Asymtomatic
94/2	HM	>100,000	12.0	6.3	0.368	Complex adnexal lesion	Vaginal bleeding
95/1	HM	43,965	9.0	9.4	0.341	Complex adnexal lesion	Vaginal bleeding
95/7	HM	159,160	8.0	6.0	0.267	Complex adnexal lesion	Pelvic mass
		Mean	7.2	6.5	0.360		
		***STDEV	3.9	1.7	0.113		

*HM = Hydatidiform Mole: **RI = Resistant Index: ***STDEV = standard deviation

† Complete invasive mole detected instantaneously after molar pregnancy evacuation.

†† Hardly detected intratumoral flow.

Serum hCG(mIU/cc.) Median = 159,160: Maximum 16 millions; Minimum = 40,000.

Discussion

Primary treatment of Gestational Trophoblastic Tumours are chemotherapy. The remission rate now exceeds ninety percent.[6,7] Because hysterectomy is rarely indicated, uterine specimen or histopathology reports are seldom obtained. In order to understand the characteristic of GTT lesions depicted by Duplex ultrasound, the fundamental knowledge of tumor angiogenesis, vascular changes of GTT and principal of Duplex ultrasound are substantial information.

Pelvic angioghraphy is an invasive procedure and has been known as an effective procedure in demonstration of uterine tumor vessels and uterine lesions. It has been widely used before the introduction of the ultrasound. The characteristic of vascular patterns and lesion of GTT has been thoroughly investigated. In order to understand the vascular supply of GTT, a literature search was performed to seek the publications in English that reported on investigations of imaging by pelvic angiography. The blood supply shown by pelvic angiogram in GTT was found to have increased significantly and was far greater than pregnant uterus of similar size.[8] The uterine arteries usually show a greater increase in size.[9] Many irregular vascular spaces, which become evident during the late arterial phase and drain into large veins, terminating in the iliac and ovarian veins. Irregular vessels which may sometimes be seen extending outside the apparent lateral border of the uterus,are indicative of parametrial extension[8] Important characteristic features included arteriovenous fistula, small irregular cavity within tumour, and an usually large number of visible intramural arteries and veins, particularly in the vicinity of the tumour. In radiogram the vessels and cavities seem to be almost confluent.[10] There are cases showing the areas of central avascularity in angiographic studies. The central areas of most nodules of choriocarcinoma or invasive mole consist of blood clot and amorphous fibrinoid material. The active growing tumour is found at the periphery of such nodules in association with fresh hemorrhages and large vascular channels. In some small tumours, uterine vessels may have normal caliber and normal pelvic angiographic images.[8]

Developments in Doppler ultrasound, in particular the ability to display a Doppler frequency spectrum in real-time (Duplex scan) and to set a sample volume to record only those ultrasound signals returning from fixed locations on the ultrasound image, have been important in bringing this method to clinical utility. This increased blood flow is demonstrated as higher velocities during systole and by a marked increase in diastolic blood flow due to lower impedance and increased signal amplitude. Increased signal amplitude makes the signal much easier to detect. The higher systolic and diastolic Doppler shifts in GTT when compared with postabortal, gravid and non gravid uterus has also been reported.[11] Tumors often contain abnormal vascular channels that lack muscle in the wall. Because smooth muscle in the arteriole is the site of peripheral resistance in normal vessels, it might expected that abnormal, thin-walled vessels would exhibit low impedance signals with little systolic and diastolic variation, thus providing another way to characterise tumour blood flow. The increased diastolic flow implied abnormal vascularity in this region and the calculated RIs (Resistant Index) confirm this.[12,13] The hypervascularity and arterio-venous shunts apparently enhance the sensitivity of Doppler ultrasound in the detection of GTT.[14]

The images producing by B-scan transvaginal ultrasound were grouped according to WHO scoring system. The early lesions or lesions in low risk tend to be hypoechoic interspersed by small irregular vascular channels which look like small cystic spaces or cavities (Fig.1). Central necrotic spaces identified in many cases (Fig.4) are comparable with cavities in pelvic angiogram. The turbulent flows (Fig.5) and low impedance flows (Fig.2) were abundant.

Patients in the high risk category had prolonged the interval of disease. Serum hCG was remarkably high. The uterus tends to be enlarged and occupied by inhomogeneous hypervascular intramyometrial and/or adnexal masses. The lesions tended to be larger than low risk cases and contained hypo and hyper echogenic texture interspersed with vascular channels and cystic vascular spaces. At the center of the large lesion, avascular area was observed and few moderate impedance vessels at the periphery were noted in case nos. 93/6,93/13. Histopathology report of hysterectomy specimen in case no. 93/13 confirmed choriocarcinoma with necrotic tissue at the central part of the lesion as were stated in the revision of angiographic reports.

Duplex transvaginal ultrasonography was able

to cover the complex mass at the adnexa which was extended from the uterine lesion in three high risk patients (Table 4). This finding has impacted on anatomical staging (FIGO) and reminded the physician who decides to perform hysterectomy on this case about the chance of facing the uncontrolled hemorrhage. Knowing exactly where the lesions are located could avoid unnecessary curettage and the hazards resulting from uterine perforation and hemorrhages. Occasionally, large intrauterine lesion is depicted right after the evacuation of molar pregnancy such as in case no.92/10. Closed observation and urgent chemotherapy are indicated to avoid uterine perforation and pelvic hemorrhage.[15]

When the serum level of hCG is low such as in cases in table 1, the lesion are unable to be depicted by Duplex scan. In this study, the lowest level of hCG that could detected by Duplex scan was 1,150 mIU/ml in table 2. The other report was over 700 uIU/ml.[16] Several factors had impacted on the lowest hCG threshold in detection of lesion, such as the sensitivity of the ultrasound machine, metastatic lesion elsewhere, the persistent of vascular flow after treatment[17,18] and during spontaneous regression such as case no.95/2 in Table 2.

Transvaginal Duplex ultrasound could not be used as a single diagnostic tool for GTT because the images and flow patterns are non specific. During this study period, echogenic lesions with high flow and low impedance flow have been depicted in missed abortion, interstitial pregnancy and ampullary pregnancy and uterine arteriovenous malformations. The appearance of lesions is indistinguishable from invasive trophoblastic neoplasia.

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