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SONO-ELASTOGRAPHY EVALUATION OF PELVIC MASSES WITH PATHOLOGICAL CO-RELATION.

Radiodiagnosis

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ABSTRACT

Aim and objectives: to evaluate the accuracy of Sono- elastography of pelvic masses with pathological co-relation.
Material and method: a prospective observational study was carried out in the department of radiology in AVBRH Sawangi Wardha a rural tertiary care hospital. 87 female patients were selected according to predefined inclusion and exclusion criteria. Hitachi Aloka arietta 70s ultrasound machine with trans-vaginal probe (5-11MHz) was used for evaluation of patients. Pathological correlation was done with FNAC/ Biopsy/ Histopathology
Results: Sensitivity, Specificity and Diagnostic accuracy of sono-elastography was calculated tobe 93.06%, 86.67% and 91.95% respectively.

KEYWORDS

pelvic masses, sono-elastography, strain elastography, pelvic malignancy.

INTRODUCTION:
Pelvic mass of gynaecological origin can present at any age group in lifetime. Approximately 20% of the total women population around the world are at risk of developing some pelvic mass of gynaecological origin at certain point in their lifetime and many of these women will have to undergo unnecessary laparoscopies/laparotomies [1].A woman presenting with an abdominal or pelvic mass might present with a number of varied symptomslike a distended abdomen, either due to a solid or a cystic mass or a solid cystic mass lesion or by free fluid in the abdomen or patients can be asymptomatic. To distinguishbetween masses and free fluid, ultrasound is the modality of choice. Pelvic Gynecologicalmasses can be 1) Uterine: Molar pregnancy Uterine fibroids, adenomyosis, uterinte tumours, Hematometra/ pyometra 2)Tubal origin: Hydro-/pyosalpinx, Tubo-ovarian abscess, Old ruptured extrauterine pregnancy (abdominal, tubal pregnancy)3) Ovarian origin:Ovarian torsion, Benign cyst, Endometrioma, polycystic ovarian disease, various malignant tumors 4)Endometrial origin: masses include endometrial hyperplasia, endometrial polyp, endometrial carcinoma.[2]Ultrasonography provideswith the diagnosis, determines the organ of origin and helps to distinguish benign lesions from malignant. Important recent advance in the field of ultrasonography is introduction of sono-elastography.

Real-time elastography (RTE) is a, recent, novel and a dynamic imaging technique that is based on the characterisation of stiffness of tissues or organs of interest under the suitable compression and is often coupled with conventional ultrasonography (US) probes after performing gray-scale imaging. Displacement of softer tissues is greater as compared to the hard tissues, and the tissue hardness is then displayed as a color-coded image that lays over the gray-scale US image translucently [3]. The principle of the ultrasonographic technique is based on applying slight external tissue compression on the structure to be examined, which produces strain (displacement) within the tissue, with subsequent calculation of the strain profile along the axis of compression (using thealgorithm to produce the elastography image). The strain profile is laterconverted into an elastic modulus imagecalled an elastogram. The calculated elasticity values are then color-coded and superimposed on the translucent, corresponding B-mode scan image. The stiffness of the tissue is displayed in a range of colour from red (i.e. the softest components) to blue (i.e. the hardest components). The components with average strain are displayed as green [4]. Elastography helps differentiating benign pelvic masses from malignant based oncharacterisation of tissue stiffness and has a role in imaging for various gynaecological pelvic pathologies.

Fibroids: Uterine fibroids are the most frequently occurring benign tumors originating in the uterus, and are usually round or partially rounded in shape. Although they are composed of the same smooth-muscle fibres as the uterine wall, they are many times denser than the normal myometrium. This characteristic is frequently responsible for the poor visualization of fibroids on trans-vaginal ultrasonography, due to strong acoustic shadowing.On elastography Fibroids appear as well circumscribed, encapsulated mass shows characteristic swirled pattern and is composed of dense myometrial tissues which imparts hardness and on elastography appears dark blue. [4]

Adenomyosis: Adenomyosis is defined as the presence of ectopic endometrial mucosa within the myometrium. Its prevalence varies widely, from 5 to 70 %, with a mean of 20 – 30 % in surgical findings [5]. In general fibroids are darker than, Adenomyosis is brighter than the adjacent myometrium.On elastography it shows softer colours with less strain ratio.[6]

Endometrial hyperplasia: Endometrial hyperplasia is characterized by a proliferation of endometrial glands resulting in a greater gland-to-stroma ratio than observed in normal endometrium.On elastography it shows softer colours with less strain ratio. [7]

Endometrial polyp: Endometrial polyps are benign nodular protrusions of the endometrial surface, and can be sessile or peduncalated. On elastography it shows softer colours with less strain ratio. [8]

Endometrial carcinoma: Carcinoma of the endometrium is among the most common female pelvic malignancies and may develop in normal, atrophic, or hyperplastic endometrium. The most common histologic type, endometriod adenocarcinoma (Eca), accounts for 75–80% of diagnoses and commonly is associated with long-term, unopposed estrogenic stimulation.[9] In endometrial carcinoma the endometrial wall and the polypoidal mass are stiffer and thus giving it a dark blue colour on elastography. [10]

Cystic ovarian lesion: Ovarian cystic neoplasms can be either benign or malignant and can arise from epithelial, stromal, or germ cell components. In general, the risk of malignancy in unilocular cystic tumours <10 cm in women over the age of 50 years is thought to be low. [11]. on elastography cystic lesions typically shows blue-green-red pattern (BGR). [12]

Malignant ovarian lesion: Malignant ovarian lesions are detected on elastography by identifying stiffer tissues within the lesion. [12]

Ectopic pregnancy refers to the implantation of a fertilised ovum outside of the uterine cavity. Which on ultrasound appears as an empty uterine cavity with a positive UPT with cystic lesion in the adnexa and free fluid in the pouch of Douglas and on elastography the lesion

appears dark blue due to the stiff tissue noted in ectopic gestation called the blue eye sign[13].

Benign and malignant cervical masses: Cervical polyps are polypoidal growth projecting into the cervical canal. Whereas malignant lesions are stiffer and hence dark blue colour on elastography. If a lesion was scored 1 to 3, it was considered benign; if a lesion was scored 4 or 5, it was considered malignant.[14]

MATERIAL AND METHODS :

Collection of data: this prospective study was conducted with approval of institutional ethical committee. A total of 87 patients referred for ultrasound were analysed for a period of 2years. Real time trans-vaginal ultrasound elastography was performed using Hitachi Aloka Arietta 70s ultra-sound machine with trans-vaginal transducer (5-11MHz).

Inclusion Criteria

- All patients referred to radio-diagnosis department of AVBRH for evaluation of pelvic masses.

Exclusion Criteria for patients being

- Post-operative patients,
- Patient with recurrenceof a pelvic mass,
- Patients on chemotherapy and radiotherapy and
- Patients not willing to be a part of the study.

Technique: The patient is informed about the procedure and consent is taken to perform the procedure. A female attendant always accompanied the patient. History of menstrual cycle is taken and if the patient is bleeding physiological/pathological the appointment was rescheduled. The patient is placed in lithotomy position and the trans-vaginal probe(5-11MHz) is covered with a condom and then inserted into the vagina. When a pelvic mass is seen gentle pressure is applied with the trans-vaginal probe and elastograms obtained.

Interpretation criteria for sonographic elastography criteria:
Two interpretation criteria i.e. elastography score, strain ratio (wherever applicable) were recorded for evaluation for sonographic elastography.

Tsukuba scoring system: The ES was interpreted according to the 5-point Tsukuba classification proposed by Itoh et al:-

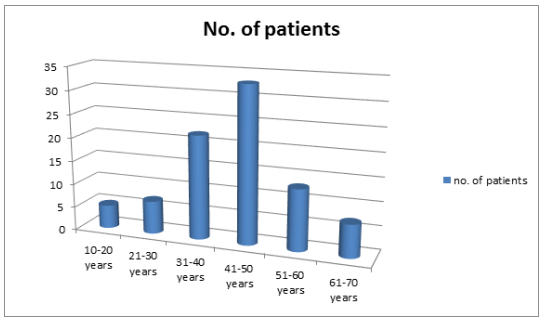
- A score of 1 indicates even strain for the entire hypo-echoic lesion (*i.e.,* the entire lesion was evenly shaded in *green*).
- A score of 2 indicates strain in most of the hypo-echoic lesion, with some areas of no strain (*i.e.,* the hypo-echoic lesion has a mosaic pattern of *green* and *blue*).
- A score of 3 indicates strain at the periphery of the hypo-echoic lesion, with sparing of the centre of the lesion (*i.e.,* the peripheral part of the lesion was *green*, and the central part was *blue*).
- A score of 4 indicates no strain in the entire hypo-echoic lesion (*i.e.,* the entire lesion was *blue*, but its surrounding area was not included).
- A score of 5 indicates no strain in the entire hypo-echoic lesion or in the surrounding area (*i.e.,* both the entire hypo-echoic lesion and its surrounding area were *blue*).

Also a BGR pattern was noted which was noted in cystic lesion.

Lesions categorized as ES 1, 2 were considered benign, and lesions categorized as ES 4 and 5 were suspicious for malignancy. [15]

Strain ratio measurement: Calculation of the SR was based on a comparison of the average strains measured in the lesion and adjacent tissue at the same depth. This method may provide another diagnostic method in addition to the 5-point scoring system used with ultrasonic elastography in the future [16]. Strain ratio value cut offs for different organs or tissues are different and based on the literature we had kept for ovarian: > 3 for malignancy [17]. For differentiating endometrial carcinoma and endometrial hyperplasia a strain value cut off of >7.2 for endometrial carcinoma and < 4 for endometrial hyperplasia. [7]. Forcervical lesion the strain ratio values of malignant lesions were much higher than those of benign lesions cut off value of >4.5 for malignant and < 4.5 or benign lesions were used. [14]

Bar diagram No1: Age wise distribution of patients:-



Bar diagram No 2: Presenting complaint:

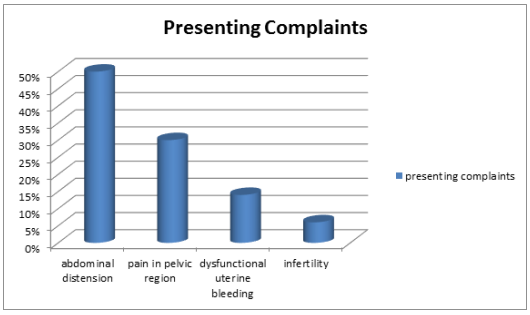


Table No. 1: Spectrum of diseases with pathological co-relation:

Pathologies	No of patients	Percentage
Uterine pathologies:	(43)	(49.42%)
Fibroids:	29	33.33%
Adenomyosis:	3	3.44%
Endometrial hyperplasia:	2	2.29%
Endometrial polyp:	3	3.44%
Endometrial carcinoma:	6	6.89%
Adnexal	(37)	(42.52%)
Ÿ Ovarian:		
Ÿ Cystic-		
Simple-	6	6.89%
Complex cystic.	3	3.44%
Dermoid-	2	2.29%
Endometrioma (chocolate cyst)-	2	2.29%
Polycystiv ovarian disease-	2	2.29%
Ovarian hyperstimulation syndrome-	2	2.29%
Ÿ Carcinoma of ovaries	12	13.79%
Ÿ Tubal:		
Ectopic pregnancy:	5	5.74%
Hydro/pyosalpinx:	3	3.44%
Cervical:	(7)	(8.04%)
Cervical polyp:	2	2.29%
Cervical carcinoma	5	5.74%
Total	87 patients	

Pie diagram No. 1: Pathological diagnosis of pelvic masses:

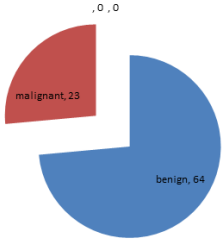


Table No. 2: Ultrasound characterisation of the lesion: solid, cystic and mixed.

Nature of lesion:	No patients	Percentage
Solid lesions	53	60.91%
Cystic	20	22.98%
Mixed	14	16.09%

Table No. 3: Ultrasonography and elastography imaging features:

Benign lesion	Ultrasound features	Elastography
Fibroids (uterine and cervical)	Well defined rounded hypoechoiec lesion with some lesions showing calcification and cystic degeneration	Dark blue colour due to stiff uterine smooth muscles.
Adenomyosis	Focal or diffuse Myometrium thickening predominantly of the posterior wall with multiple tiny endometrial cyst	Softer colour on elastography than adjacent myometrium..
Endometrial hyperplasia	Endometrial thickness ranging for 12-17mm in premenopausal and > 5mm in post-menopausal.	Softcolour on elastography scale (green and red)
Endometrial polyp	Endometrial thickening with a stalk and feeding vessel.	Soft colour on elastography scale (green and red)
Simple ovarian cyst	Anechoic lesion >3cms in size.	BGR pattern
Haemorrhagic ovarian cyst	Cystic lesion >3cms with internal echoes, septations and debris.	BGR pattern
Ovarian Dermoid cyst	Cystic ovarian mass withheterogeneousecho texturewith presence of fat and calcification	Green and blue colours with some stiff areas due to variegated tissues.
Endometrioma	Unilocular cyst with acoustic enhancement and diffuse homogenous ground glass echoes	BGR pattern
Benign ovarian neoplasm	Typically cystic lesion appearing anechoic and with internal echoes in mucinous cystadenoma	BGR pattern
Polycystic ovarian disease	Bulky ovaries with peripherally arranged multiple follicles	Combination of stiff and soft colours (blue and red)
hydrosalpinx	Serpiginousanechoic lesion in the adnexa in the region of fallopian tubes	BGR pattern
Ectopic pregnancy	Tested positive for pregnancy with empty uterine cavity and adnexal mass with +/-free fluid in pouch of Douglas	Blue eye sign
Malignant lesion		
Endometrial carcinoma	Ill-defined lesion in the endometrium causing thickening of the endometrium and occasionally with myometrial invasion	Dark blue colour on elastography with high strain ratio.
Ovarian carcinoma	Ill defined, mostly solid ovaries with heterogeneousecho texture.	Dark blue colour
Cervical carcinoma	Ill-defined thickening of the cervix	Dark blue colour with high strain ratio.

Table No. 4: Tsukuba Elastography score for pelvic masses:-.

Tsukuba score	No. of patients	Percentage
1	03	3.44%
2	19	21.83%
3	-	-
4	43	49.42%
5	2	2.29%
BGR	20	22.98%
Total	87	

Table No. 5: Strain ratio of fibroids:

Strain ratio	No. of patients	Percentage
1-3.0	14	48.27%
3.1-5.0	08	27.58%
5.1-8.0	07	24.13%
Total	29	

Table No. 6: sensitivity, specificity and accuracy of Ultrasound.

Sensitivity	90.28%
Specificity	80%
Accuracy	88.50%
Ppv	95.59%
Npv	63.16%
P value	0.0001

Table No. 7: sensitivity, specificity and accuracy of Elastography.

Sensitivity	93.06%
Specificity	86.67%
Accuracy	91.95%
Ppv	97.10%
Npv	72.22%
P value	0.0001

RESULTS:-

Majority of the patients in our study were from the age group of 41-50 years followed by 31-40 years. Principle presenting complaint was abdominal distension followed by pain in the pelvic region. The majority of the pathologies that were encountered were uterine in origin(49.42%) in which fibroids constituted the maximum number of patients(33.33%) followed by adnexal origin in which benign ovarian lesions were found predominantly(19.54%) and followed by malignant ovarian lesions(13.79%). The total number of benign lesions encountered in our study was 64 accounting for (74%) of the total cases and malignant lesions were found in 23 patients accounting for (26%) of the total cases. As per ultrasound most the lesions were solid (53) accounting for (50.91%) followed by cystic and then mixed (solid-cystic). Majority of the lesions were of score 4 of tsukuba scoring system. Maximum number of fibroids had strain ratio between 1 and 3. Sensitivity, specificity and accuracy of ultrasound were 90.28%, 80%, 88.50% respectively. Sensitivity, specificity and accuracy of elastography were found to be 93.06, 86.67 and 91.95% respectively.

Discussion:

In our study 38% of the patients were found in the age group of 41-50 followed by 25% from the age group 31-40 yrs. Findings were coherent with studies conducted by Gupta KP, Jain SK et al [18] and Tripathi et al [19] which concluded with maximum patients from the age group 31-50 years followed by >50years and then followed by 20-30years and 10-20years of age group. The results were coherent with similar studies conducted by Pillai SS et al [20].

We observed that the incidence of malignancy increases with increase in the age with a vast majority of the cases were found in >50 years(31.3%).It was also observed that malignancy was inversely proportional to parity with decrease in the number of cases with increase in the parity. Similar results were found in the study conducted by Alessandrino et al [21].Uterine and adnexal pathologies comprised of a majority of the patients with uterine comprising of 49.42% and adnexal being 42.5% combined to 91.9% of the total number of patients followed by cervical pathologies. Similar Findings were seen in studiesconducted by Pillai SS et al [20] which concluded with a vast majority of the patients diagnosed with uterine pathologies and then followed by ovarian and cervical pathologies. Similar findings were alsoreported by Tripathi Et al [19].Out of the total 29 cases diagnosed with fibroids a vast majority of the patients were diagnosed with intramural fibroid 79.4% followed by sub-serosal and sub-mucosal fibroid accounting for 10.3% each. Similar findings were found in a study by Ami Et al.[4]. These results were also coherent with studies conducted by Stoelinga et al.[6]. In our study, strain ratio for fibroids was between 1-8 with majority of the patients in between 1-3 (48.27%). This is contrary to the study conducted by P.R. Szkodziak et al where he found that the strain ratio for intramural fibroid was between (1.22-1.75). [22]. Out of the total 87 cases 3 cases were diagnosed with adenomyosis on sono-elastography. Softer colours green, red and yellow were intermixed as in adenomyosis there are small cystic areas and there is no focal dense area. Similar finding were reported by Tessarolo et al[23]. Results were also coherent with studies conducted by Stoelinga et al.[6].Out of the total 87 patients 6 were diagnosed with endometrial cancer. In endometrial carcinoma the malignant growth has stiffer tissues with higher strain values. [7]. In the adnexal pathologies cystic lesions of the ovaries constituted the majority of the cases followed by neoplastic ovarian pathologies, ectopic pregnancy, hydro and pyo-salpinx. In epithelial ovarian lesions serous cystadenoma were reported the most common pathology followed by Mucinous type. In malignant ovarian lesionserous cystadeno-carcinoma was the most common. Kawamoto S, Urban BA, Fishman EK. Et al. reported the similar findings of most common epithelial tumours [24].Hardik makwana et al, showed the similar findings of serous cystadenocarcinoma most common malignant tumour and serous cystadenoma most common benign tumour [25].Out of the total 87 patient included in the study, 5 patients were diagnosed with ectopic pregnancy. The classic blue eye sign was

depicted on sono-elastography as in ectopic pregnancy the implanted fertilised ovum causes stiffness and adjacent fluid collection appearing dark blue on elastography. Similar finding were reported by studies conducted by Vorontseva et al [13].

Limitation: one of the main limitations of this study is the acquisition of elastogram as well as analysis is observer dependant. The magnitude of initial compression could affect theelasticity map hence inter and intra-observer variability is another factor which needs to be studied.

Conclusion: Trans-vaginal Sono-elastography improves the diagnostic accuracy of gray scale ultrasound and can be reliably used to diagnose malignant pelvic masses. This can help the clinician for better patient management.

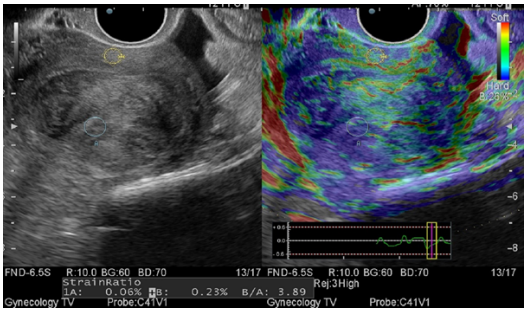


Fig1: There is e/o well defined, encapsulated hypo-echoic lesion in the posterior myometrial wall which is showing mosaic pattern of blue and green colour (elastography score 2) due to stiff tissues as seen in cases with fibroid with strain ratio of 3.89.

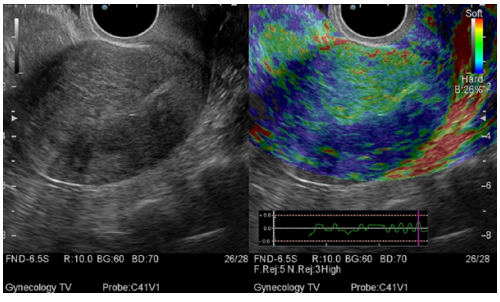


Fig2: There is e/o asymmetric thickening of the anterior myometrial wall with poor definition of endometrial myometrium border, globular uterine fundus and showingpredominantly soft colours in anterior myometrium on elastography (red and green) s/o adenomyosis.

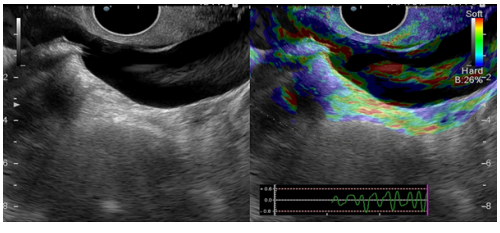


Fig3: There is e/o serpiginouscystic lesion in the left para-ovarian region showing BGR pattern on elastography s/o hydrosalpinx.

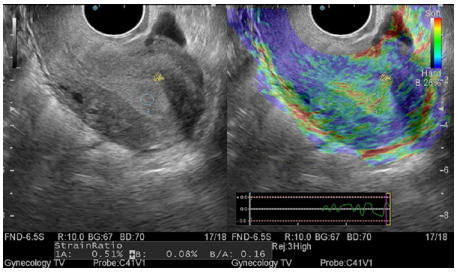


Fig4: There is e/o thickening of the endometrium with no solid component which is showing softer colours on elastography which is the green and red with strain ratio of 0.16 s/o endometrial hyperplasia proven on biopsy.

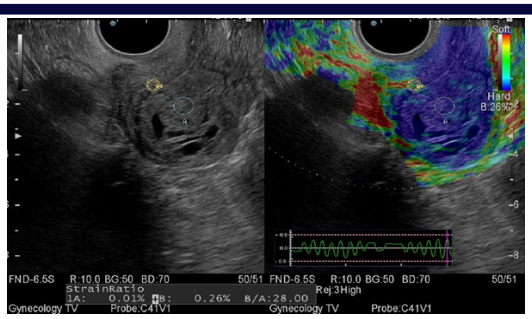


Fig 5: There is e/o ill-defined endometrial stiff mass lesion showing dark blue colour on elastography and strain ratio of 28 s/o endometrial carcinoma confirmed on biopsy.

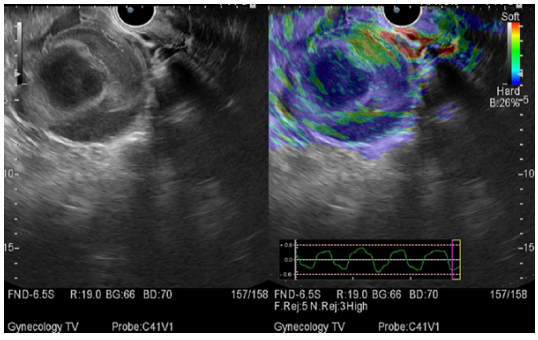


Fig6: Right adnexal solid-cystic mass showing predominantly dark blue colour on elastography and soft colours in necrotic area s/o malignant ovarian mass proved as cystadenocarcinoma in histopathology.

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