Original Research Article

Diagnostic Value of Trans-vaginal Sono- Elastography in Discrimination of Cervical Neoplasms

Abstract:

Background: Trans-vaginal ultrasound is the most widely used imaging method to screen women with cervical cancer and other cervical masses, due to its wide availability, low cost and no radiation.

Aim of the Work: This study aims to show the role of sono-elastography in differentiation between benign and malignant cervical masses. Benign tumors tend to be soft and malignant tumors tend to be hard .

Patients and Methods: The study was carried out on thirty patients, who referred to Tanta Diagnostic Radiology and Medical Imaging Department, for evaluation of clinically suspected cervical masses, during the period from March 2018 till December 2020 . Their age ranged from 37 years to 66 years with a mean age of 49.73 (±7.65 SD) years **.**

Results: This Prospective study was carried out on thirty patients, who referred to Diagnostic Radiology and Medical Imaging Department, for evaluation of clinically suspected cervical masses. Their age ranged from 37 years to 66 years old with a mean age of 49.73 years(±7.65 SD).

Conclusions: Transvaginal sonographic elastography is a promising diagnostic tool, complementary to conventional sonography for differentiating between malignant and benign endometrial lesions. Both qualitative and quantitative methods could be applied to improve the diagnostic performance of elastography, and SR has demonstrated good diagnostic performance.

Key word: Federation of Gynecology and Obstetrics, magnetic resonance imaging, computed tomography and Transvaginal ultrasonography

Introduction:

Worldwide, cervical cancer is the second most common malignancy in women [(1)]. The diagnosis of uterine cervical cancer at an early stage of the disease is a challenge. The most common clinical staging system for uterine cervical cancer is the International Federation of Gynecology and Obstetrics (FIGO), which remains the standard for staging and treatment decision in patients with cervical cancer [(2)]. It takes into account the results of the physical examination, histopathology results of biopsy, colposcopy, endoscopy (cystoscopy or sigmoidoscopy) and chest radiography[(3).]

Despite that surgical and modern imaging staging is proved to be better than clinical staging for identifying the true extent of the disease, none of these methods have been incorporated into the FIGO staging system yet. In the developing countries, absence of cervical cancer screening is the main cause of the widespread of the disease, whereas staging methods are not universally available, standardized, or comparable to those present in developed countries. Also, there is still a lack of the clinical value of surgical staging and the consensus about the best imaging modality [(4).]

Current imaging modalities used for the assessment of uterine cervical cancer include; magnetic resonance imaging (MRI), computed tomography (CT), and ultrasound. In comparison, CT has a low contrast resolution of soft-tissue, while MRI is the ideal modality for the evaluation of the cervix. However, MRI is not usually performed immediately in regard to convenience and the limitations of intra-uterine contraceptive devices. On the other side, ultrasound is gaining clinical importance because it is cheaper, less time consuming and could have similar diagnostic accuracy as MRI[(5)]**.** Transvaginal ultrasonography (TVUS) arranged with a high resolution probe, may give a clearer image of the uterine cervix and parametrial tissue [(6)]**.**

It is well-known that the malignant tissues are generally harder than adjacent normal tissues, and this could distinguish benign from malignant tissues based on their elasticity [(7)]. Real-time ultrasound elastography (USE)is a rising technique, now readily available on conventional ultrasound systems with modified software. The basic principle in ultrasound elastography, is non-invasive imaging and estimation of tissue elasticity by measuring local tissue displacements from returning ultrasonic signals before and after application of a compressive force [8].

The relative stiffness of the tissues within this area is described by colors superimposing on the B-mode image.The probes can be used to compress the tissue. The elasticity modulus is calculated from the resulting deformation of the tissue[9].

Under compression, stiff tissues show less deformation or strain than soft tissues [10]. By applying the property that malignant tissues have higher stiffness than benign tissues, ultrasound elastography has been shown to differentiate malignant from benign lesions in many organs like thyroid but, little effort was done on the detection and diagnosis of cervical cancer until now [11].

Aim of the Work

To evaluate the role of real-time trans-vaginal sono-elastography in differentiation between benign and malignant uterine cervical masses by assessment of their relative tissue stiffness, which was reflected by superimposing the elasticity color map on the B-mode image.

Patients and methods

This Prospective study was carried out on thirty patients, who referred to Diagnostic Radiology and Medical Imaging Department, for evaluation of clinically suspected cervical masses. Their age ranged from 37 years to 66 years old with a mean age of 49.73 years(±7.65 SD).

- **Duration of the study:**
  From March 2018 till December 2020.
- **Inclusion criteria:**
  - Post-menopause women.
  - Married pre-menopause women.
  - Patients, who are suspected to have cervical masses by clinical examination.
- **Exclusion criteria:**
  - Virgin.
  - Patients with history of radiotherapy.
  - Patients with cervical cancer associated with vaginal involvement which proved by gynacologist, to avoid infection and vaginal bleeding.
  - Cases without histopathological results.
  - In all studied patients, histopathological analysis was performed and considered as the golden standard reference
- No apparent risks or hazards to the patients included in this study .
- Any unexpected risks appeared during the course of the research cleared to participants and the ethical committee on time.
- An informed consent obtained from all participants in this research.
- **Privacy and confidentiality of all patients' data guaranteed and there is a code number for every patient file that include all investigations, all data provision monitored.**
- The study approved by the Ethics Committee of Faculty of Medicine, Tanta University.

- **All patients were subjected to:**

A. **Full clinical evaluation by history and clinical examination**.

1. History: complete history taking included age, residency, occupation, Parity, gravidity, previous abortion, previous pregnancy outcomes, history of the presented complain, any relevant past history.
2. Clinical examination:
   - General examination
   - Local examination

- **Ultrasonographic examination**

Real-time TV sono-elastography was carried out by using aplio XG system (Toshiba Medical System, Tokyo, Japan) with a 7.0-MH endo-vaginal probe. Patients were asked to empty bladder and lie in the lithotomy position. The TV ultrasound probe was put into the vagina about 1cm away from the cervix with a disposable condom which was used to prevent cross infection.

The ultrasound system was on the B mode and site, shape, size, and echogenicity of the cervical lesions were recorded. Then, turned to Color Doppler were used to assess the blood supply of the lesions . The highest sensitivity for detection of color Doppler signals was used, allowing detection of small blood flow velocities [12].

Then, the system was turned into elastography mode to record the stiffness of the cervix and the lesions. Support of the anterior pelvic wall by the left hand and manual compression on the cervix by the right hand were done. The parameters used were as follows: frame rate M; density 2; dynamic range 4; Persistence 6; smoothing 2; frame rejection, 4; noise rejection 2. On the B-mode images, the deformity was represented by color overlaid. The color scale ranges from blue to red to show the relative hardness or softness of tissue in the region of interest (ROI) as: tissue with average strain was colored in green, hard tissue was dark blue, moderately hard tissue in light blue, moderately soft tissue areas in yellow, and soft tissue areas in red.

Strain ratio was obtained by measuring and dividing the mean strain of the lesion by the mean strain from the parametrial tissue, if the lesion was in the anterior cervical wall, the anterior pericervical fat was taken as the reference tissue and if the lesion was in the posterior cervical wall, the posterior pericervical fat was chosen as the reference. So, sufficient parametrial tissue was essential. The reference tissue was difficult to choose if the lesions infiltrated both sides of the pelvic wall and the value of strain ratio would be questionable. However, we think that un-infiltrated uterine myometrium could be used as a reference [9].

STATISTICAL ANALYSIS

Data were fed to the computer and analyzed using IBM SPSS software package version 20.0. (Armonk, NY: IBM Corp) Qualitative data were described using number and percent. The Kolmogorov-Smirnov test was used to verify the normality of distribution Quantitative data were described using range (minimum and maximum), mean, standard deviation, median and interquartile range (IQR). Significance of the obtained results was judged at the 5% level.

RESULTS

This prospective study was conducted on thirty patients presented with clinical suspicion of cervical masses.

As shown in table (1) the age of the thirty patients ranged from 30 to 70 years. There are eleven patients with benign lesions ,and nineteen patients with malignant lesions.

The mean age of the studied patient was 49.73 (±7.65 SD) with range (37-66) years. As revealed by table (2) and fig(1).The mean age of patients with benign lesions was 56.45 (±6.62 SD) with range (45-66) years, while the mean age of cases with malignant masses was 45.84 (±5.13 SD) with range (37-52) years. Regarding age a high statistically significant difference was observed between the two groups of the studied patients.

As shown in table (3) and fig(2), most of the studied cases were malignant as revealed by histopathological results (19/30; 63.3%), while patients with benign masses were (11/30; 36.7%). Furthermore, the result of the current study revealed that more than half of the studied patients histopathologically diagnosed to have squamous cell carcinoma (53.3%), while chronic cervicitis and adenocarcinoma were detected in 10% of each of them.

As revealed by table (4) and fig(3) the mean size of detected masses of the studied patients was 25.75 (±13.86 SD) with range (2.3-51.33) cms^3. The mean size of detected benign lesions was 15.33 (±10.57 SD) with range (2.3-37.92) cms^3, while the mean size of detected malignant masses was 31.78 (±11.96 SD) with range (13.64-51.33) cms^3. According to size of detected masses a high statistically significant difference was observed between the two groups of the studied patients.

Table(5) and fig(4) demonstrated that 17 (56.7%) patients had mild vascular masses, while 6 (20%) patients showed masses with moderate vascularity and 7 (23.3%) had masses with highly vascularity. Moreover, our result revealed that most of patients with mild vascular masses had benign masses (11/17; 64.70%). Additionally all patients with moderate and highly vascularity masses had malignant masses. Regarding vascularity of cervical masses as revealed by color Doppler US a high statistically significant difference was observed between the two groups of the studied patients.

Table (6), as well as Figures (5-7) demonstrate that the mean RI among studied patients was 0.55 (±0.13 SD) with range (0.33-0.74) while for cases with Benign masses the mean RI was 0.62 (±0.07 SD) with range (0.51-0.74) and for cases with Malignant masses the mean RI was 0.51 (±0.14 SD) with range (0.33-0.72).Additionally, the mean Elasticity score among studied patients was 3.43 (±0.9 SD) with range (2-5) while for cases with Benign masses the mean Elasticity score was 2.55 (±0.69 SD) with range (2-4) and for cases with Malignant masses the mean Elasticity score was 3.95 (±0.52 SD) with range (3-5).Also, The mean SR among studied cases was 8.46 (±6.01 SD) with range (1.1-18.2) while for cases with Benign masses the mean SR was 2.05 (±0.69 SD) with range (1.1-3) and for cases with Malignant masses the mean SR was 12.18 (±4.26 SD) with range (3.4-18.2). There was high statistically significant difference between studied cases as regard Elasticity score and SR and no statistically significant difference as regard RI.

Table (1): Distribution of the studied patients (n=30) according to age.

Age in years	Benign	Malignant	Total
>30 - 40	0	3	3
>40 - 50	1	12	13
>50 - 60	7	4	11
>60 - <70	3	0	3
Total	11	19	30

Table (2): Distribution of the studied patients according to age and histopathological results (N=30)

Age (years)	Benign (N =11)	Malignant (N = 19)	t	p
Min. – Max.	45.0 – 66.0	37.0 – 52.0	4.905*	<0.001*
Mean ± SD.	56.45 ±6.62	45.84±5.13		
Median (IQR)	58.0(51.50–61.50)	48.0 (41.50– 50.0)		

Min: Minimum, **Max**: Maximum , **SD:** Standard deviation, **IQR:** Interquartile range, **N:** Number, **t:** Student t-test , **p: p** value for comparing between the studied groups , ***:** Statistically significant at $p \leq 0.05$

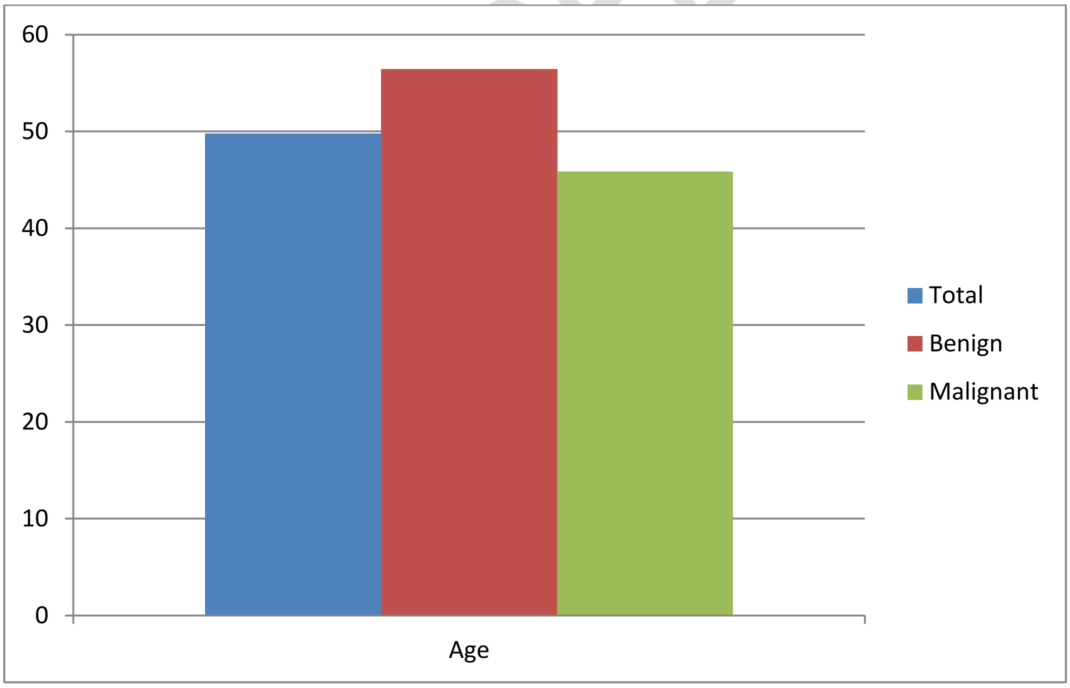


Fig (1): Distribution of the studied patients according to age and histopathological results

Table (3):Distribution of the studied patients according to histo-pathological results (N=30)

Histopathological Diagnosis	N	%
Benign (N)	11	36.7
Polyps	4	13.3
Chronic cervicitis	3	10.0
Leiomyoma	4	13.3
Malignant (N)	19	63.3
Squamous cell carcinoma	16	53.3
Adenocarcinoma	3	10.0

N: Number, **%:** percent

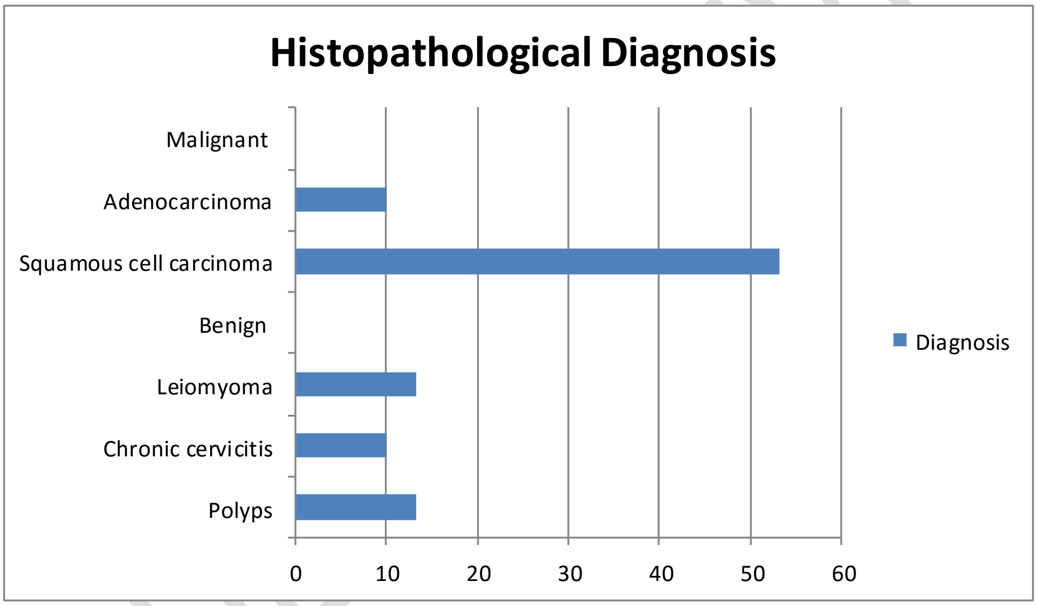


Fig (2): Distribution of the studied cases according to diagnosis

Table (4): mean size of the detected masses in the studied patients. (N=30)

Size (cm) of detected masses	Benign (N =11)	Malignant (N = 19)	U	p
Min. – Max. (2.30–51.33)	2.30–37.92	13.64–51.33	31.50*	0.001*
Mean ± SD.(25.75±13.86)	15.33±10.57	31.78±11.96		
Median (IQR): 23.80(14.0–36.90)	11.16(9.0–18.66)	33.0(20.97–39.78)		

Min: Minimum, **Max**: Maximum , **SD:** Standard deviation, **IQR:** Interquartile range, **N:** Number, **cm:** centimeter , **U:** Mann Whitney test , **p: p** value for comparing between the studied groups , ***:** Statistically significant at $p \leq 0.05$

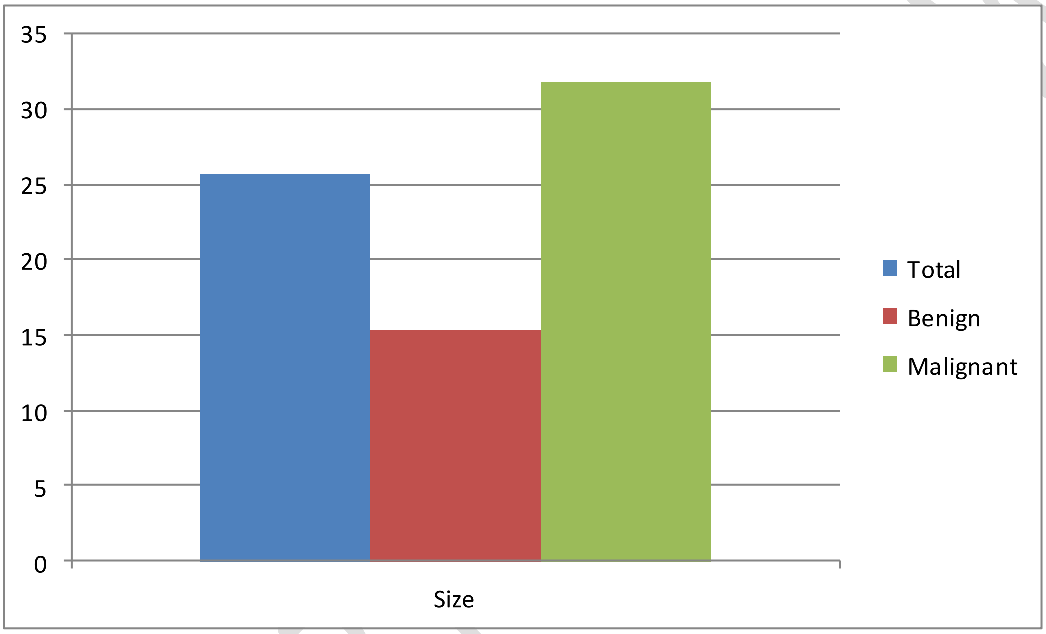


Fig (3): mean size of the detected masses in the studied patients. .

Table (5): Distribution of the studied patients according to the vascularity of cervical masses as revealed by color Doppler US (N=30)

Vascularity as revealed by color Doppler US N;%	Benign (N =11)		Malignant (N = 19)		χ^2	^{MC}p
	N	**%**	**N**	**%**		
Mild vascular (17; 56.7)	11	100.0	6	31.6	12.860*	0.001*
Moderate vascular (6; 20.0)	0	0.0	6	31.6		
Highly vascular (7; 23.3)	0	0.0	7	36.8		

N: Number, **%:** percent, χ^2: Chi square test , **MC:** Monte Carlo
p: p value for comparing between the studied groups, ***:** Statistically significant at $p \leq 0.05$

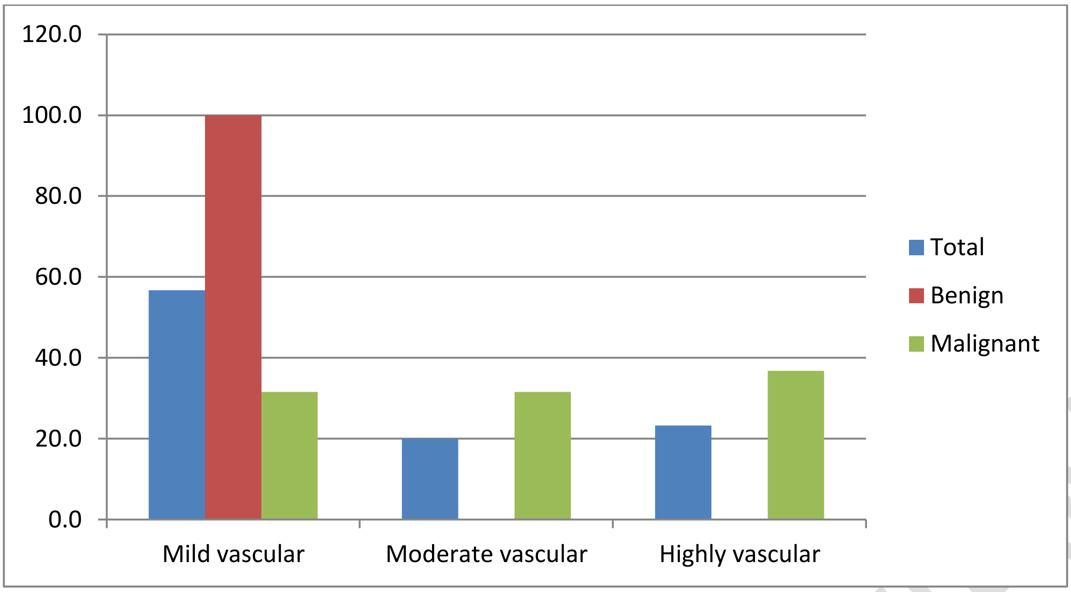


Fig (4): Distribution of the studied patients according to the vascularity of cervical masses as revealed by color Doppler ultrasound.

Table (6): Distribution of the studied patients according to imaging parameters (N=30)

Imaging parameters	Benign (N =11)	Malignant (N = 19)	U	p
RI				
Min. – Max. (0.33 – 0.74)	0.51 – 0.74	0.33 – 0.72	60.0	0.057
Mean ± SD. (0.55 ±0.13)	0.62 ±0.07	0.51 ±0.14		
Median (IQR): 0.57 (0.43–0.68)	0.61 (0.57–0.65)	0.45 (0.40–0.68)		
Elasticity score				
Min. – Max. (2.0 – 5.0)	2.0 – 4.0	3.0 – 5.0	16.0*	<0.001*
Mean ± SD. (3.43 ±0.90)	2.55 ±0.69	3.95 ±0.52		
Median (IQR): 4.0 (3.0–4.0)	2.0(2.0–3.0)	4.0 (4.0–4.0)		
SR				
Min. – Max. (1.10 – 18.20)	1.10 – 3.0	3.40 – 18.20	0.0*	<0.001*
Mean ± SD. (8.46 ±6.01)	2.05 ±0.69	12.18 ±4.26		
Median (IQR): 9.20 (2.50–13.40)	2.20 (1.50–2.50)	12.70 (9.95–15.0)		

RI: Resistive Index, **SR:** strain Ration, **Min:** Minimum, **Max**: Maximum , **SD:** Standard deviation, **IQR:** Interquartile range, **N:** Number, **cm:** centimeter , **U:** Mann Whitney test , **p: p** value for comparing between the studied groups , ***:** Statistically significant at $p \leq 0.05$

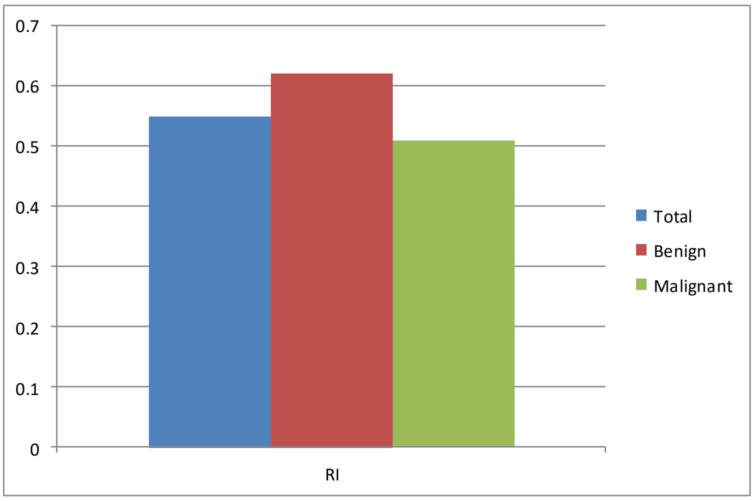


Fig (5): Distribution of the studied patients according to Resistive Index

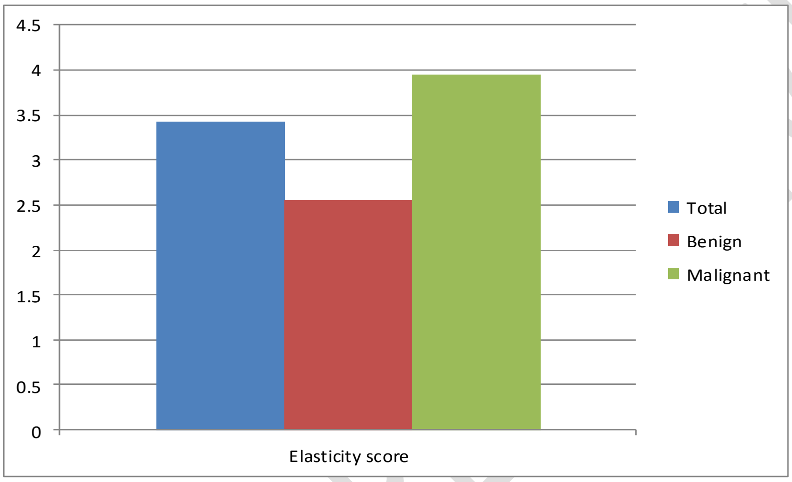


Fig (6):Distribution of the studied patients according to Elasticity score.

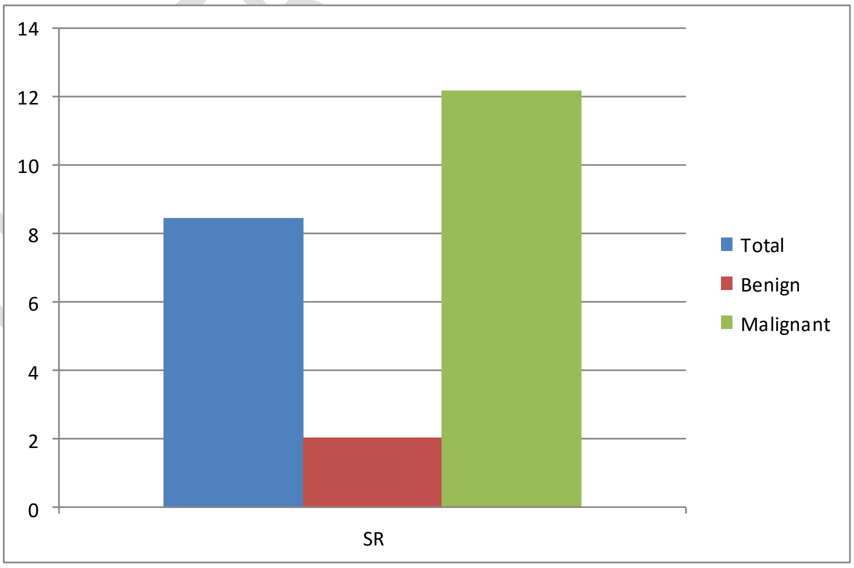
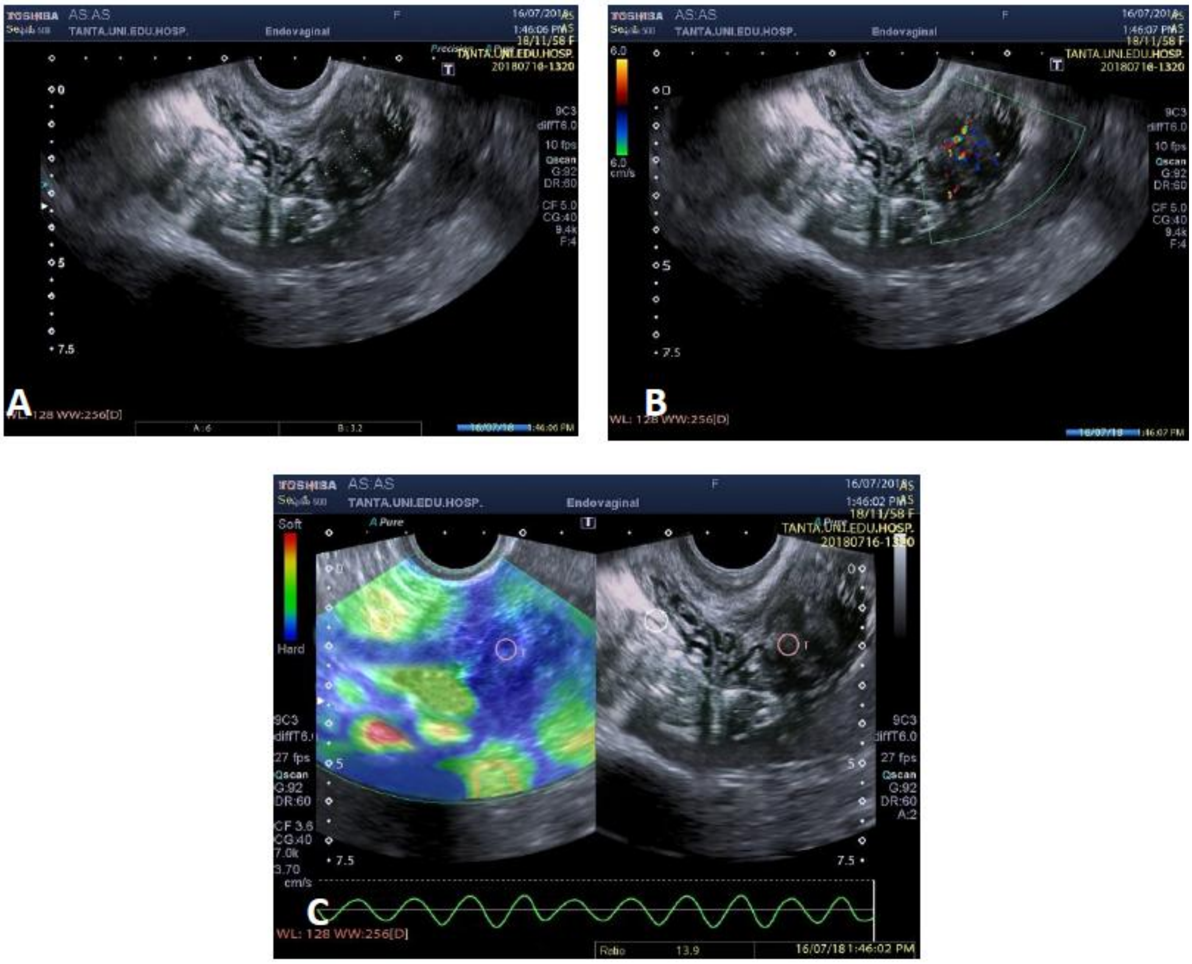
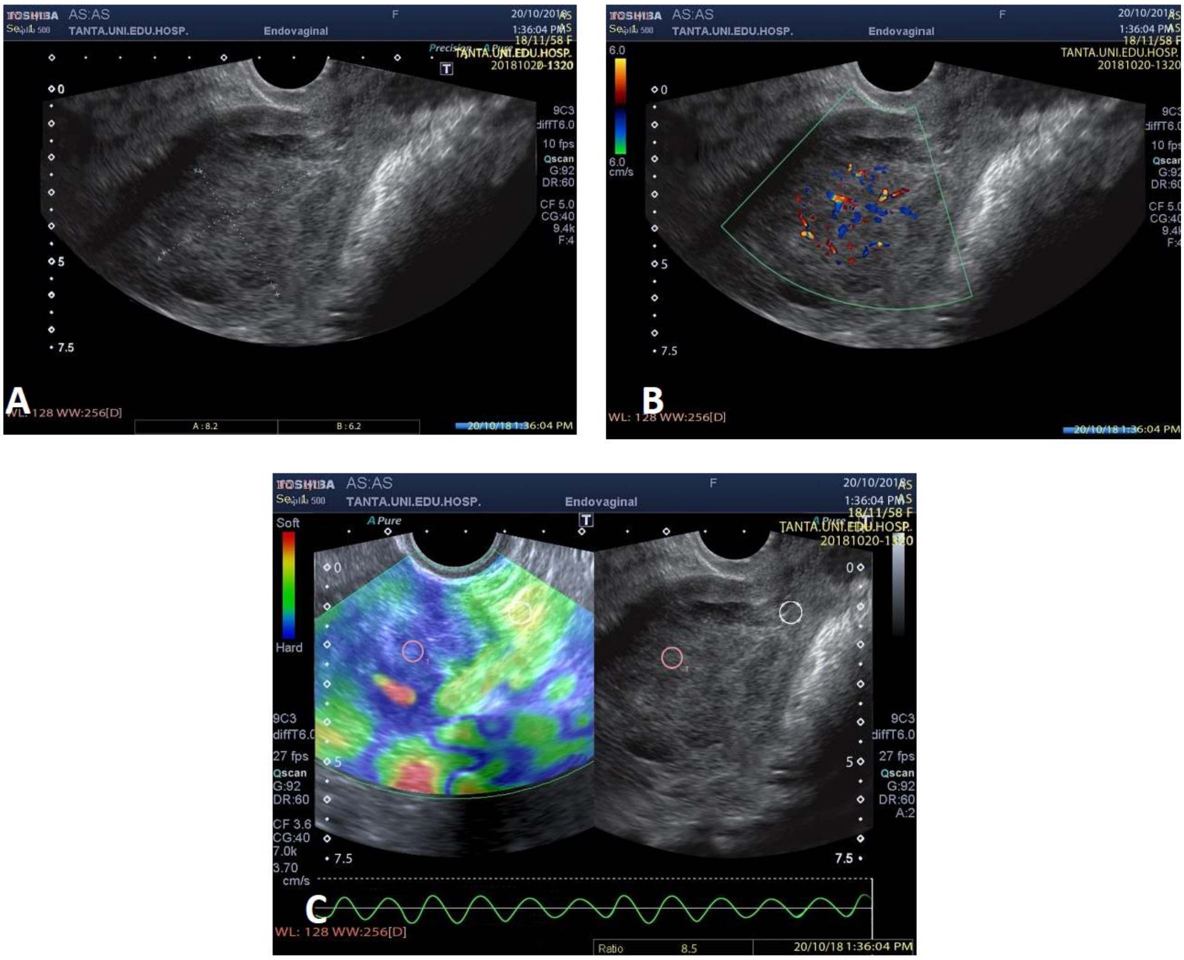


Fig (7):Distribution of the studied patients according to Strain Ratio.

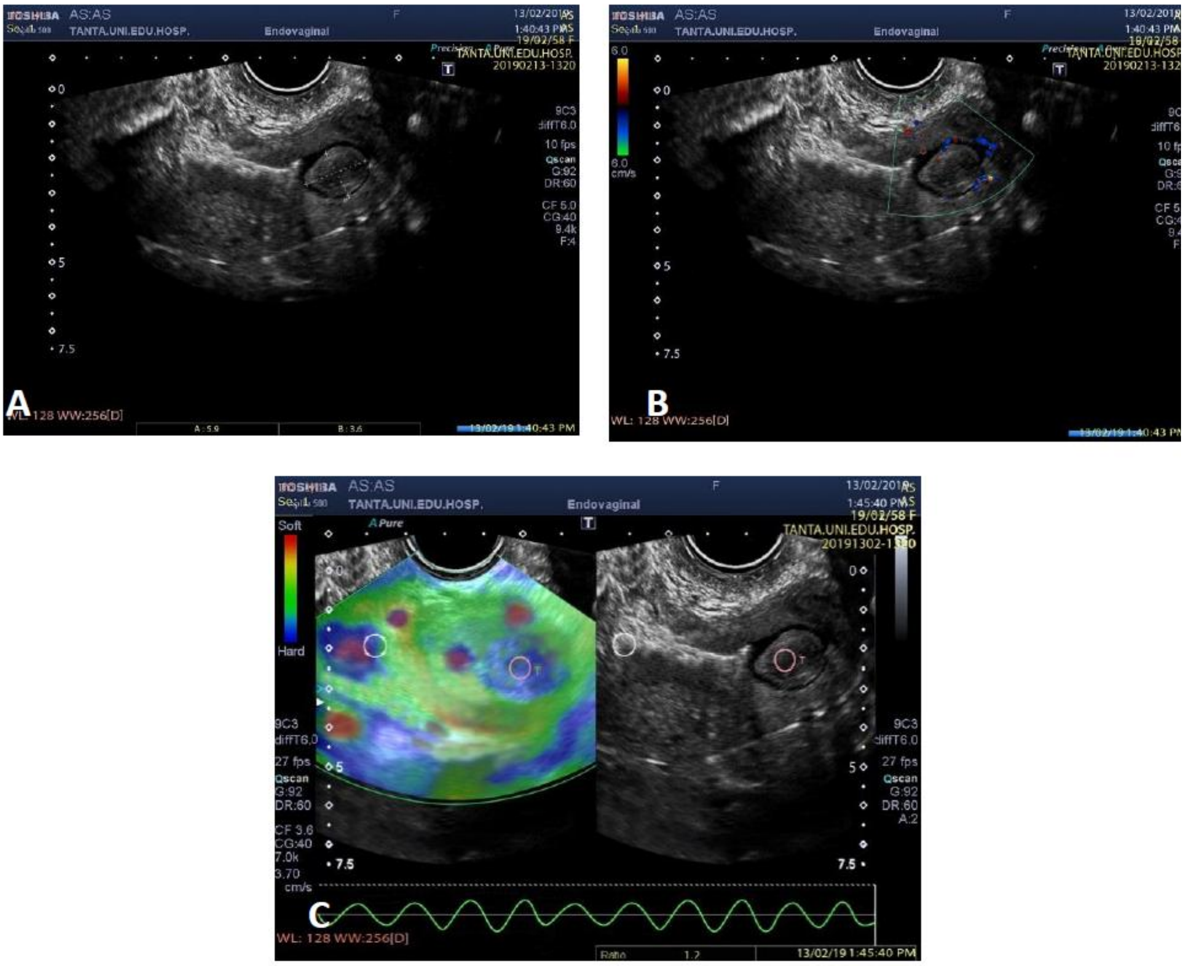
Cases



Case 1 : A forty-one years old female patient with malignant cervical mass (confirmed to be adenorcinoma by pathological examination).B-mode ultrasound image (A) shows isoechoic mass infiltrating the uterus measuring 6 X 3.2 cm. Power Doppler image (B) shows moderate vascularity of detected cervical mass. TV elastogram (C) shows that the mass had an elasticity score of 4 and strain ratio was 13.9



Case 2 : A fifty-one years old female patient with malignant utrine mass extend to the cervical (confirmed to be squamous cell carcinoma by pathological examination).B-mode ultrasound image (A) shows hypoechoic mass infiltrating the uterus measuring 8.2 X 6.2cm. Power Doppler image (B) shows moderate vascularity of detected cervical mass. TV elastogram (C) shows that the mass had an elasticity score of 3 and strain ratio was 8.5.



Case 3 : A fifty-eight years old female patient with well defined polyp of the cervix (confirmed to benign leiomyoma by pathological examination).B-mode ultrasound image (A) shows isoechoic mass measuring 5.9 X 3.6cm. Power Doppler image (B) shows mild vascularity of detected cervical mass. TV elastogram (C) shows that the mass had an elasticity score of 3 and strain ratio was 1.2

DISCUSSION

Real-time ultrasound elastography is a rising technique, now readily available on conventional ultrasound systems with modified software. The basic principle in ultrasound elastography, is non-invasive imaging and estimation of tissue elasticity by measuring local tissue displacements from returning ultrasonic signals before and after application of a compressive force. Under compression, stiff tissues show less deformation or strain than soft tissues. Applying the property that malignant tissues have higher stiffness than benign tissues, ultrasound elastography has been shown to differentiate malignant from benign lesions in the prostate, breast, liver, pancreas, lymph nodes, and gastrointestinal tract**(Zhi, et al., 2007)[13].**

The TVUS arranged with a high-resolution probe, may give a clearer image of the uterine cervix and parametrial tissue. It is well-known that the malignant tissues are generally harder than adjacent normal tissues, and this could distinguish benignly from malignant tissues based on their elasticity**(Sun, et al., 2012) [6].**

This is why this study was selected to be conducted to evaluate the role of real-time trans- vaginal sono-elastography in differentiation between benign and malignant uterine cervical masses by assessment of their relative tissue stiffness, which were reflected by colors superimposing on the B-mode image.

This Prospective study was carried out on thirty patients, who would be referred to Diagnostic Radiology and Medical Imaging Department, for evaluation of clinically suspected cervical masses on duration from March 2018 until December 2020.

Regarding demographic characteristics, The mean age for total cases was 49.73 (±7.65 SD) with range (37-66) years while for cases with Benign masses the mean age was 56.45 (±6.62 SD) with range (45-66) years and for cases with Malignant masses the mean age was 45.84 (±5.13 SD) with range (37-52) years. There was high statistically significant difference between the studied cases as regard Age.

Cervical cancer is the most common carcinoma of the genital tract in women, with an age-standardized incidence of 8.9 cases per 100,000 women/year, and an estimated 150,000 new cases per year in China, particularly in young women. The diagnosis of cervical cancer now relies on specialized clinical examinations, computed tomography (CT), magnetic resonance imaging (MRI) and ultrasound. Compared with CT, which has a low contrast resolution of soft tissue, MRI is the ideal modality for visualization of the cervix. However, it is not usually possible to perform MRI immediately due to inconvenience and the limitations of contraceptive devices. By contrast, ultrasound is gaining clinical interest since it is less time consuming, cheaper, noninvasive and safe, particularly for patients undergoing repeated examination**(Zhang, et al., 2011[14]).**

The present study shows that the diagnosis of masses was distributed as for 11 (36.6%) benign cases there were 4 (13.3%) Polyps, 3 (10%) Chronic cervicitis and 4 (13.3%) Leiomyoma for 19 (63.3%) Malignant cases there were 16 (53.3%) Squamous cell carcinoma and 3 (10%) Adenocarcinoma.Among the cases there were 14 (46.7%) Hypoechoic, 6 (20%) Mixed echogenicity and 10 (33.3%) Isoechoic. In the Benign cases there were 5 (45.5%) Hypoechoic, 1 (9.1%) Mixed echogenicity and 5 (45.5%) Isoechoic. In the Malignant cases there were 9 (47.4%) Hypoechoic, 5 (26.3%) Mixed echogenicity and 5 (26.3%) Isoechoic. There was no statistically significant difference between studied cases as regard Echogenicity.

In the study of **Sun, et al., 2012**[(6)], thirty-six patients were diagnosed as negative except nabothian cysts after TVUS examinations, including 6 cases of cervical erosion, 3 case of cervical polyp, 10 cases of inflammation, and 17 cases of cervical cancers in early stage. The hyper echoic serosa of these patients was connective and smooth, the hypo echoic cervical canal was distinguished and the cervical stroma was homogeneous except the anechoic nabothian cysts. Ten cases benign and 64 cases of malignant lesions were correctly diagnosed by TVUS. In the benign group, 6 patients were found to have spot-like echogenic focus surrounding the cervical os. Pathological results of these patients were 3 cases of cervical erosion and 3 cases of cervical inflammation. Two patients with cervical polyps were correctly diagnosed because a hyperechoic protrusion was detected in the cervical canal. Fifty-eight solid masses were detected including 2 cases of leiomyomas, and 56 cases of cervical carcinomas.

According to **Su ,et al. 2013**[(15)], the 58 malignant lesions all appeared solid on B-mode sonography, and all were hypoechoic. According to their morphologic characteristics, boundary, echoes on gray scale sonography and color Doppler flow imaging, the sensitivity, specificity and diagnostic accuracy were 78.95, 77.97 and 78.45%, respectively.

Real-time sono-elastography is a new emerging method to describe the mechanical properties of tissue. It is similar to color Doppler ultrasonography in that a region of interest is defined. The relative stiffness of the tissues within this area is described by colors superimposing on the B-mode image. Real-time elastography can be performed with linear transducers for trans-cutaneous use, rigid endo-cavitary probes and with flexible echo-endoscopes. The probes can be used to compress the tissue. The elasticity modulus is calculated from the resulting deformation of the tissue**(Janssen, et al., 2008)**[(10)]**.**

The current study shows that the mean size among studied cases was 25.75 (±13.86 SD) with range (2.3-51.33) cms while for cases with Benign masses the mean Size was 15.33 (±10.57 SD) with range (2.3-37.92) cms and for cases with Malignant masses the mean Size was 31.78 (±11.96 SD) with range (13.64-51.33) cms. There was high statistically significant difference between the studied cases as regard size.

Our results are supported by study of **Shady, et al. 2015** [(9)] as they reported that the mean surface area of all lesions in the patients' group was 8.35 ± 4.07 cm2. Mean surface areas of the primary cancer cervix, recurrent cancer cervix and fibroid lesions were 7.68 ± 3.15 cm2, 5.80 ± 2.77 and 12.18 ± 5.27 cm2 respectively.

In the study of **Sun, et al. 2012** [(6)], mean size of these masses was 17.9 ± 8.1 mm. Two of them got hydronephrosis or non-functioning kidney. Eight cases of early cervical cancers were diagnosed because of increased blood supply, though no obvious hypo-echoic mass was detected.

Cervical cancer remains an important health issue, especially in the developing countries that account for about 85% of the world burden of cervical cancer. Doppler ultrasound play important role on evaluation of blood flow patterns of the uterine arteries in pre- and postmenopausal women with cervical cancer and other cervical masses especially through resistive index (RI)**(Zaria, et al., 2020)**[(16)]**.**

In the study in our hands, among the cases there were 17 (56.7%) Mild vascular, 6 (20%) Moderate vascular and 7 (23.3%) Highly vascular. In the Benign cases there were 11 (100%) Mild vascular. In the Malignant cases there were 6 (31.6%) Mild vascular, 6 (31.6%)

Moderate vascular and 7 (36.8%) Highly vascular. There was no statistically significant difference between studied cases as regard vascularity.

In the study of **Shady, et al. 2015**[9], twenty-four lesions of the 27 primary cancer cervix lesions had high vascularity at power Doppler imaging, 4 lesions of the 5 recurrent cancer cervix lesions had high vascularity and none of the 8 fibroids showed central vascularity with only peripheral vascularity at power Doppler imaging.

Sonoelastography remains a primary method for the diagnosis of cervical cancer. Compared with cervical biopsy, which is the gold standard, women are more likely to accept noninvasive examination. A previous study has shown that there is a statistical difference of elasticity between malignant and normal cervical tissue. The stiffer the object, the larger the elastic modulus. Malignant tissues are stiffer than benign tissues. Therefore, the elastic modulus of the former is greater than that of the latter. Cervical tissues mainly comprise collagen fiber and a few muscle fibers. Although cervical tissues may undergo changes to elasticity under different physiological conditions, for example, the elasticity may be affected by pregnancy or the menstrual cycle, the normal elasticity of cervical tissues does not change with age**(Thomas, et al., 2007)**[(7)]**.**

The present study shows that the mean RI among studied cases was 0.55 (±0.13 SD) with range (0.33-0.74) while for cases with Benign masses the mean RI was 0.62 (±0.07 SD) with range (0.51-0.74) and for cases with Malignant masses the mean RI was 0.51 (±0.14 SD) with range (0.33-0.72). The mean Elasticity score among studied cases was 3.43 (±0.9 SD) with range (2-5) while for cases with Benign masses the mean Elasticity score was 2.55 (±0.69 SD) with range (2-4) and for cases with Malignant masses the mean Elasticity score was 3.95 (±0.52 SD) with range (3-5).

The mean SR among studied cases was 8.46 (±6.01 SD) with range (1.1-18.2) while for cases with Benign masses the mean SR was 2.05 (±0.69 SD) with range (1.1-3) and for cases with Malignant masses the mean SR was 12.18 (±4.26 SD) with range (3.4-18.2). There was high statistically significant difference between studied cases as regard Elasticity score and SR and no statistically significant difference as regard RI.

Our results are supported by study of **Thomas, et al. 2007** [(7)] as they reported that two readers jointly assessed the color distribution in the ROIs of all 113 cervices using an analog scale from 1 (definitely normal) to 5 (definitely abnormal). In their assessment, the readers paid special attention to the presence of focal blue areas (hard tissue) and failure to delineate the cervical contour or anatomic structures such as the cervical canal. The subjective scores differed significantly between the normal group (1.8 0.7) and patients with cervical lesions (3.5 0.9) (P 0.000089). Both readers found the grading classification defined for cervical assessment practical.

Furthermore, **Shady, et al. 2015**[(9)] found that mean SR of the control group was 2.46 ± 0.46. Mean SR of the diseased group was 10.41 ± 2.59. Mean SRs of the cancer cervix, recurrent cancer cervix and fibroid lesions were 11.51, 10.60 and 6.65 respectively. Comparison of all SRs revealed that mean SR of the diseased group was significantly higher than that of the control group (P < 0.0001). Also, mean SR of the malignant lesions (primary and recurrent cancer cervix) was significantly higher than that of the benign lesions (fibroid) (P < 0.0001).

Elastography has emerged as a useful adjunct tool for sonographic diagnosis. Elastograms are images of tissue stiffness and may be in color, grayscale, or a combination of the two. The first and most common application of elastography is for diagnosis of breast lesions, where studies have shown areas under the receiver operating characteristic curve of 0.88 to 0.95 for distinguishing cancer from benign lesions. The technique is also useful for diagnosis of complex cysts, although different scanners may vary in how they display such lesions**(Garra, et al., 2011)[(17)].**

The current study shows that Using roc curve, it was shown that RI can be used to diagnose malignant cases with slightly difference but no statistically significant difference (P=0.055) at a cutoff level of ≤ 0.5, AUC of 0.713, 95% C.I (0.524-0.902), with 57.89% sensitivity, 100% specificity, 100% PPV, 57.9% NPV and73% accuracy. Using roc curve, it was shown that Elasticity score can be used to diagnose malignant cases with high statistically significant difference (P<0.001*) at a cutoff level of >3, AUC of 0.923, 95% C.I (0.815-1.032), with 84.21% sensitivity, 90.91% specificity, 94.1% PPV, 76.9.9% NPV and accuracy 86.67%. Using roc curve, it was shown that SR can be used to diagnose malignant cases with high statistically significant difference (P<0.001*) at a cutoff level of >3, AUC of 1.0, 95% C.I (1-1), with 100% sensitivity, 100% specificity, 100% PPV, 100% NPV and accuracy 100%.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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