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Using B-Mode Ultrasonography, Doppler, and Strain-Wave Elastography in differentiating Submucosal Fibroid and Intrauterine Polyps

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Abstract: ***Abnormal uterine bleeding is a commonly encountered entity in pre-menopausal and post-menopausal women, with endometrial polyps and submucosal fibroids being common etiologies. The first-line imaging examination in the diagnosis of endometrial polyps as well as submucosal fibroids is ultrasound, but its accuracy is not apparent. Elastography is an ultrasound-based imaging modality used to assess the stiffness of examined tissues. Because endometrial polyps derive from soft endometrial tissue and submucosal fibroids are made of hard muscle tissue, elastography seems a promising tool to differentiate between such lesions. We aim to assess whether strain elastography may be used to visualise the difference in stiffness of endometrial polyps and submucosal fibroids. This was followed up on the pathological results post-operatively. It was demonstrated in this study that strain-wave elastography makes assessing the stiffness of intrauterine lesions possible, which may help differentiate between endometrial polyps and submucosal fibroids. However, other ancillary findings like vascularity in Doppler imaging and echogenicity in B mode ultrasound can greatly help distinguish between the two entities. Combining all these modalities will help us achieve greater diagnostic confidence in differentiating submucosal fibroids from intrauterine polyps, as concluded by this study.***

Keywords: Strain elastography, B-mode ultrasound, Color Doppler, Endometrial polyps, Submucosal fibroids.

1. Introduction

Endometrial polyps and submucosal fibroids are common causes of abnormal uterine bleeding (AUB) and, less commonly, infertility. The prevalence of such intrauterine lesions increases with age during the reproductive years and usually decreases after menopause. The first-line imaging examination in the diagnosis of endometrial polyps as well as submucosal fibroids is ultrasound, but its accuracy is not obvious.[1] Elastography is an ultrasound-based imaging modality that is used to assess the stiffness of examined tissues. Because endometrial polyps derive from soft endometrial tissue and submucosal fibroids are made of hard muscle tissue, elastography seems a promising tool to differentiate between such lesions.[1]

Up to 30% of women of reproductive age seek medical assistance due to abnormal uterine bleeding.[2] Transvaginal sonography is the first-line imaging examination for abnormal uterine bleeding.[3] The role of power Doppler imaging in diagnosing endometrial disorders has been reported.[4] B mode ultrasonography shows predominant hypoechogenicity in submucosal fibroids, and polyps are predominantly hyperechoic. Doppler study shows a predominant stalk-like vascularity in endometrial polyps and a broad base diffuse vascularity in submucosal fibroids. Strain elastography assesses the stiffness of tissues qualitatively, and strain ratios are displayed in a colour map for comparison. A recently published study showed that elastography based diagnoses were in excellent agreement with those of magnetic resonance imaging for fibroids and adenomyosis.[5] Interestingly, it has been demonstrated that in vitro uterine ultrasound strain imaging may help distinguish endometrial polyps and fibroids.[6] This study aimed to assess whether strain elastography may be used to visualize the different stiffness of endometrial polyps and submucosal fibroids and compare its efficacy with B mode sonography and power Doppler imaging with subsequent histopathological correlation.

2. Material and Methods

Study Type: Prospective Monocentric single-operator study.
Study Setting: Department of Radiodiagnosis, JMCH.
Study Period: June 2023 to December 2023.
Sample Size: 20 patients with AUB and B mode ultrasonography showing endocavitary lesions.
Sampling Method: Consecutive sampling method.
Machine: Mindray Resona,
Probe: I9V11-3Hs, Intracavitary probe.
Patients are referred from the Department of Obstetrics and Gynecology, JMCH.

Inclusion Criteria:
Patients were referred from the Department of Obstetrics and Gynecology with abnormal uterine bleeding with clinical suspicion of endometrial polyps and submucosal fibroids and giving consent for examination.

Flow Chart of the Study Design
- 20 patients with AUB and B mode ultrasonography showing endocavitary lesions were selected.

- B MODE, DOPPLER suggests either an intrauterine polyp or submucosal fibroid.
- Strain Elastography was done and a presumptive diagnosis was made.
- The patient was followed up after the HPE results.

Exclusion Criteria
- Patients who don't consent to the study.
- On hormone therapy.
- B mode ultrasonography is not suggestive of submucosal fibroid or intrauterine polyp.
- Intramural or sub-serosal fibroid.

Procedure

We conducted a prospective monocentric single-operator study on diagnostic accuracy. Patients having abnormal uterine bleeding and having undergone transvaginal sonography reporting suspected endometrial polyps and submucosal fibroids were included. Before the elastograpy readings were acquired, all patients underwent routine B mode grayscale ultrasound and Color Doppler examinations. Additionally, the stiffness of intrauterine lesions was assessed by strain elastography. The enhancement was adjusted to visualize the hard myometrium and soft endometrium around the intrauterine lesion. Color-coded stiffness maps were projected and compared. Red denoted hard; green denoted soft and yellow denoted intermediate stiffness. Sonographic, power Doppler and elastographic findings were verified by histopathologic examinations after surgery. The diagnostic accuracy of sonography, color doppler imaging, and strain elastography was compared using the McNemar test.

Statistics

Statistical analyses were performed with SPSS software. (SPSS ver 24.0, IBM Corporation, USA) for MS Windows. Descriptive data were shown as median (range) because of a non-normal distribution. The main outcome measures were B-mode sonography, strain elastography, and pathologic diagnoses of the type of intrauterine lesion. The sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy were calculated for B-mode sonography, power Doppler imaging, and strain elastography to predict endometrial polyps. To compare the diagnostic accuracy of B-mode sonography, power Doppler imaging, and strain elastography, all findings were classified as correct or incorrect according to the results of the histopathologic examinations. The accuracy of B-mode sonography, Doppler imaging, and strain elastography in differentiating endometrial polyps and submucosal fibroids was compared by the McNemar test. Age and parity in patients with endometrial polyps and submucosal fibroids were compared by the Mann-Whitney *U* test. $P < .05$ was considered significant.

3. Results

Table 1: Age group Distribution

Age group	N
40-50	6
>50	14

54 Years is the median age

Table 2: Duration of symptoms

<1month	2
1-3 months	5
3-6 months	13

Mode is 3-6 months

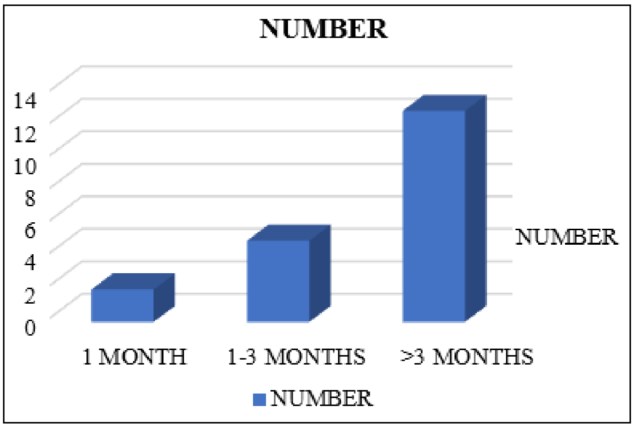

Figure 1: Symptomatic Duration

Table 3: Parity

Multiparous	12 (polyp=5, fibroids =7)
Nulliparous	8 (polyp=3, fibroids=5)

Table 4: B Mode USG finding

Echogenicity	Possible pathology	
Hyperechoic	Polyp	9
Hypoechoic	Intrauterine fibroid	11

Table 5: Color Doppler finding

Number	Pathology	Number
Stalk like vascularity	POLYP	12
Diffuse myometrial-Endometrial vascularity	SUBMUCOSAL FIBROID	8

Table 6: Strain elastography findings

Strain Elastography	Number
Red (Hard)	7
Green (Soft)	13

Table 7: HPE findings

Outcomes by HPE	NUMBER
Polyps	8
Submucosal Fibroids	12

4. Observations

Based on the obtained data, here are the results of the statistical analysis:

<u>**Sensitivity and Specificity**</u>

- HPE (Gold Standard)

Table 8(a): B-Mode Ultrasound Statistical values (Polyps)

Polyps:	HPE +	HPE -
Screening +	4	3
Screening -	5	8

Sensitivity = 44.4%
Specificity = 72%
Positive predictive value =57%
Negative predictive value = 61%

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Table 8(b): B-Mode Ultrasound Statistical values (Fibroids)

Submucosal fibroids	HPE +	HPE -
Screening +	8	3
Screening -	5	4

Sensitivity = 61%
Specificity = 57%
Positive predictive value = 72%
Negative predictive value = 36.3%

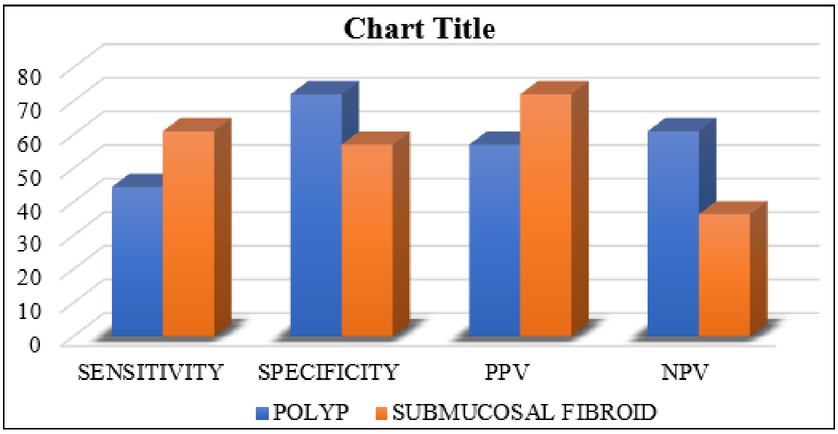

Figure 2: Comparison of submucosal fibroid and polyp detection on B-mode ultrasound

DIAGNOSTIC ACCURACY for polyps using B MODE = 60%
DIAGNOSTIC ACCURACY for SUBMUCOSAL FIBROIDS using B MODE =60%

Strain Wave Elastography

Table 9(a): Strain wave elastography Statistical values (Polyps)

Polyps:	HPE +	HPE -
Screening +	6	7
Screening -	1	6

Sensitivity = 85.71 %
Specificity = 46.15 %
Positive predictive value = 46.15 %
Negative predictive value = 85.71 %
DIAGNOSTIC ACCURACY FOR POLYPS AND FIBROIDS USING STRAIN ELASTOGRAPHY = 60%

Table 9(b): Strain wave elastography Statistical values (Fibroids)

Submucosal fibroids	HPE +	HPE -
Screening +	6	1
Screening -	7	6

Sensitivity = 46%
Specificity = 85.7%
Positive predictive value = 85.7%
Negative predictive value = 46.15%

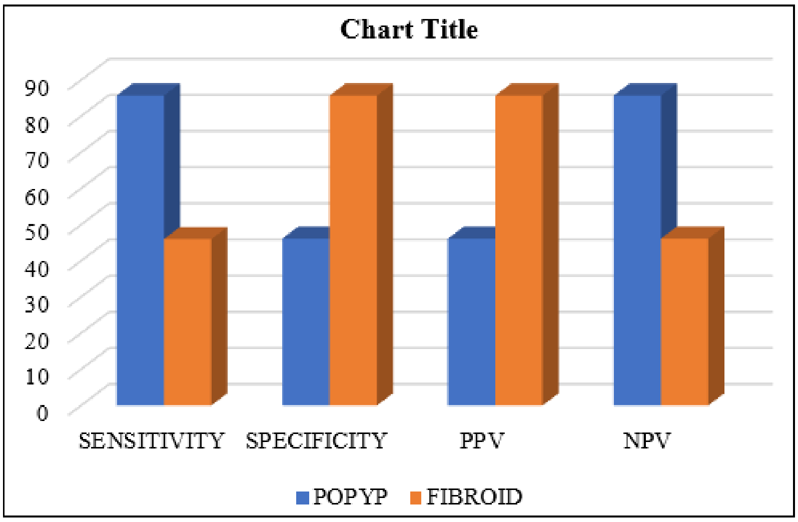

Figure 3: Comparison of submucosal fibroid and polyp detection by strain elastography

Color Doppler

Table 10 (a): Color doppler elastography Statistical values (Polyps)

Polyps:	HPE +	HPE -
Screening +	6	7
Screening -	1	6

Sensitivity = 85.71%
Specificity = 46.15%
Positive predictive value = 46.15%
Negative predictive value = 85.71%

Table 10 (b): Color doppler elastography Statistical values (Fibroids)

Submucosal fibroids	HPE +	HPE -
Screening +	7	1
Screening -	6	6

Sensitivity = 53.8%
Specificity = 85.71%
Positive predictive value = 87.5%
Negative predictive value = 50%

Diagnostic Accuracy For
1) POLYPS= 60%
2) FIBROIDS USING COLOR DOPPLER = 65%

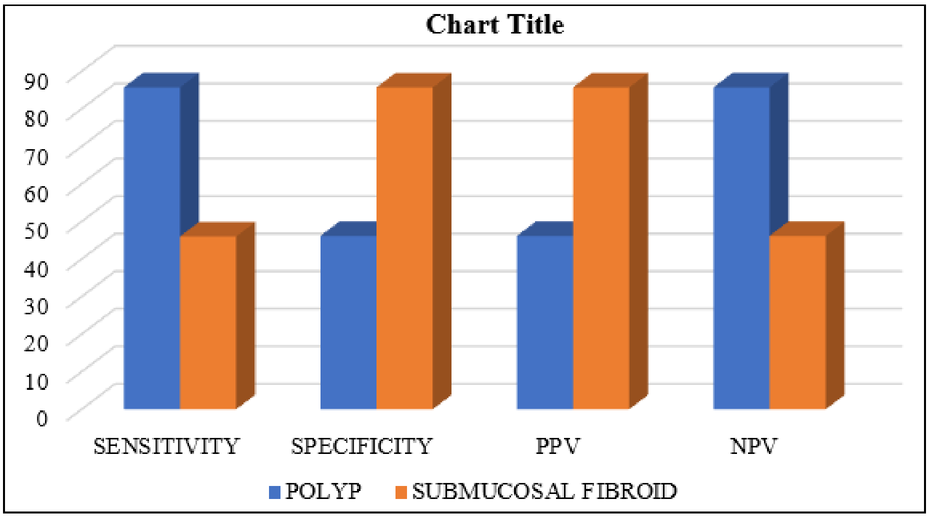

Figure 4: Comparison of submucosal fibroid and polyp detection by color doppler study

McNemar's Test (Comparison with HPE)

COLOR DOPPLER VS STRAIN ELASTOGRAPHY

The p-value associated with this McNemar statistic is calculated as p = 0.414 and suggests difference between the two modalities is not statistically significant.

COLOR DOPPLER VS B MODE ULTRASONOGRAPHY

A value of 0.14 indicates no significant difference in diagnostic performance between Color Doppler and B-mode.

STRAIN ELASTOGRAPHY VS B-MODE ULTRASONOGRAPHY

p = 0.786 and it indicates no significant difference in diagnostic performance between the two modalities.

Pearson Correlation Coefficient (r)

Correlation between B-Mode Ultrasound and color doppler: p-value: approximately 0.405 indicating that the correlation is not statistically significant.

Correlation between color doppler and strain elastography:

The Pearson correlation coefficient (r) is approximately 0.103, indicating a weak positive correlation between Color Doppler and HPE.

Mann-Whitney U test table or calculator derives from the collected data:

- There is a significant difference in the number of polyps between the two age groups (p = 0.005).
- There is a significant difference in the number of fibroids between the two age groups (p = 0.001).
- There is a significant difference in the number of polyps between multiparous and nulliparous women (p = 0.005).
- There is a significant difference in the number of fibroids between multiparous and nulliparous women (p = 0.028).

5. Discussion

The findings of this study highlight the diagnostic accuracy of various modalities in detecting polyps and submucosal fibroids. Hobson et al[7] suggested using ultrasound strain imaging to differentiate endometrial polyps, fibroids, and adenomyosis. In another study, the authors concluded that elastography allows for the assessment of the presence of a uterine fibroid or adenomyosis, which helps differentiate between both focal findings.[8] McNemar test showed that the proportion of correct findings was significantly higher for strain elastography than for B-mode sonography and Doppler imaging.[9] Our results also show that Strain Wave Elastography has a significantly higher sensitivity and specificity for polyps than B-mode ultrasound and color Doppler. However, for submucosal fibroids, color Doppler has a higher sensitivity and specificity compared to Strain Wave Elastography and B-mode ultrasound, which was statistically not in line with previous journals.[10]

The strong positive correlations between the modalities indicate they are highly related and can be used complementarily to improve diagnostic accuracy. The moderate to substantial agreement between the modalities suggests that they can be used interchangeably in some cases.

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The significant differences in the performance of the modalities highlight the importance of choosing the appropriate modality for the specific diagnostic task. The high sensitivity and specificity of Strain Wave Elastography for polyps make it suitable for detecting these lesions. On the other hand, Color Doppler's high sensitivity and specificity for submucosal fibroids make it a better choice for detecting these lesions. Overall, the findings of this study emphasize the importance of multimodal diagnostic approaches and highlight the potential benefits of combining different modalities to improve diagnostic accuracy. The results also underscore the need for further research to determine the optimal modalities for specific diagnostic tasks and to develop new modalities with improved diagnostic accuracy. Considering our initial experience with elastography and its previously shown usefulness in differentiating between endometrial pathologies[11], it seems reasonable to postulate that elastographic assessment of endometrial lesions should also be included in future research protocols. Additionally, the findings highlight the importance of considering the strengths and limitations of each modality when interpreting diagnostic results.

Limitations: Our study's limitation was that patients were selected according to B-mode findings, which could have potentially led to a selection bias. However, this study aimed to assess the usefulness of elastography in cases in which the lesion was visible on sonography.

Representative Cases: Figure 5 showing a case of submucosal fibroid

Figure 5(a): A hypoechoic intrauterine lesion was observed on grayscale sonography. Elastography showed that the stiffness of the lesion was similar to the myometrium and projected red areas on the elastographic color map indicating hard or a stiffer mass.

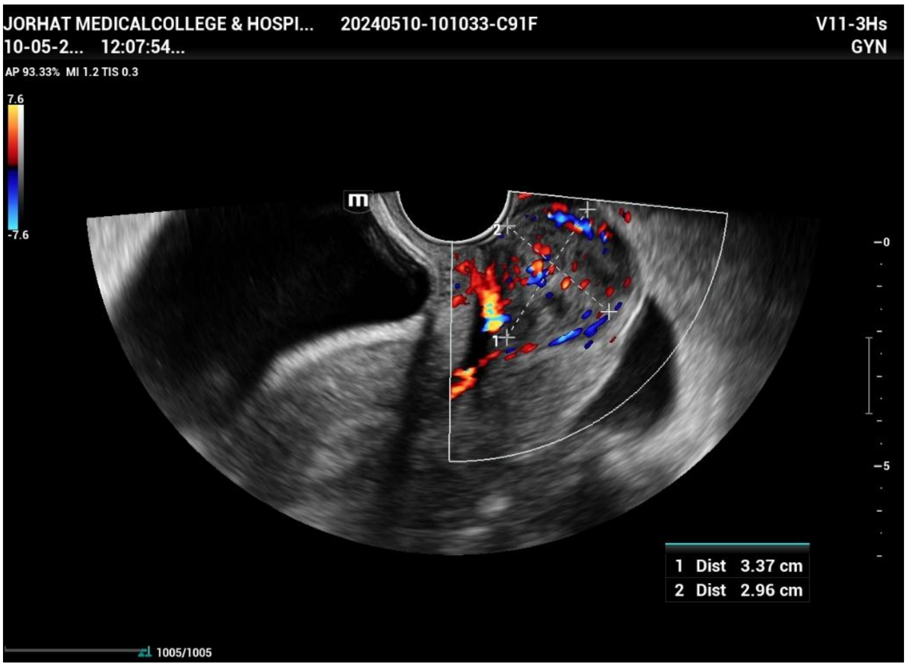

Figure 5(b): Color Doppler imaging showed a more diffuse endo-myometrial vascularity spanning the mass lesion.

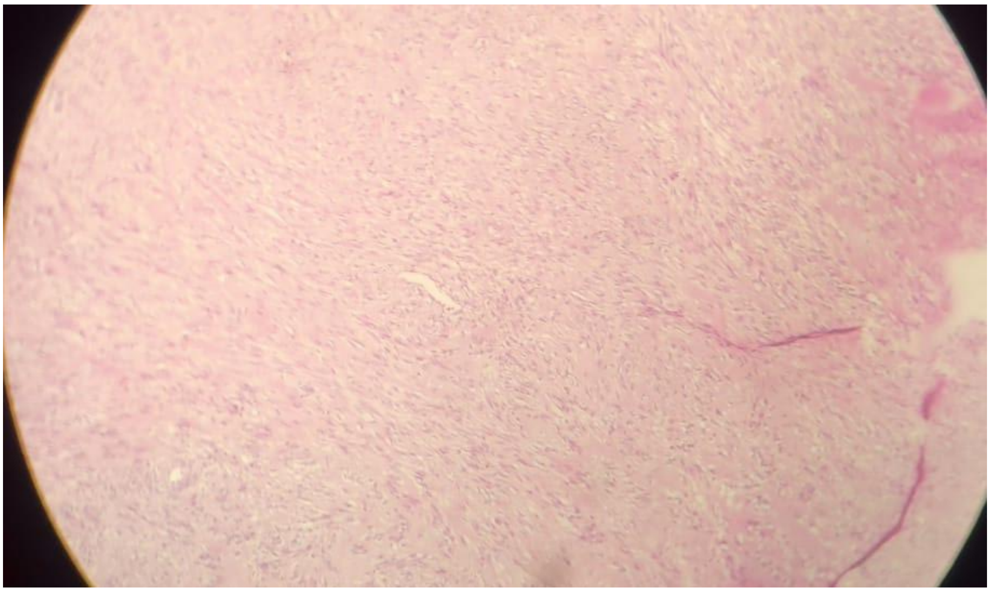

Figure 5 (c): The pathologic examination confirmed the diagnosis of a submucosal fibroid

Figure 6 showing a case of intracavitary polyp

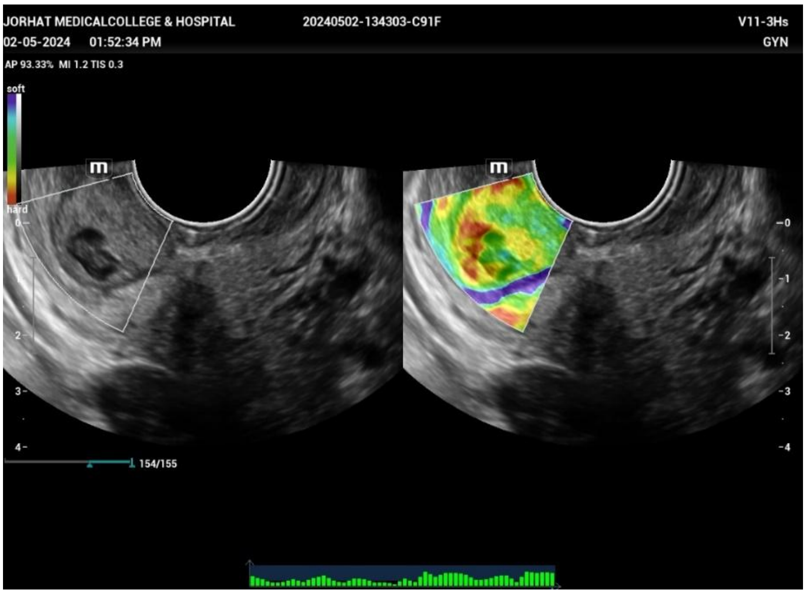

Figure 6 (a): A hyperechoic intrauterine lesion was observed on grayscale sonography. Elastography showed that the stiffness of the lesion was similar to the endometrium and projected yellow and green areas on the elastographic color map indicating soft or a less stiffness

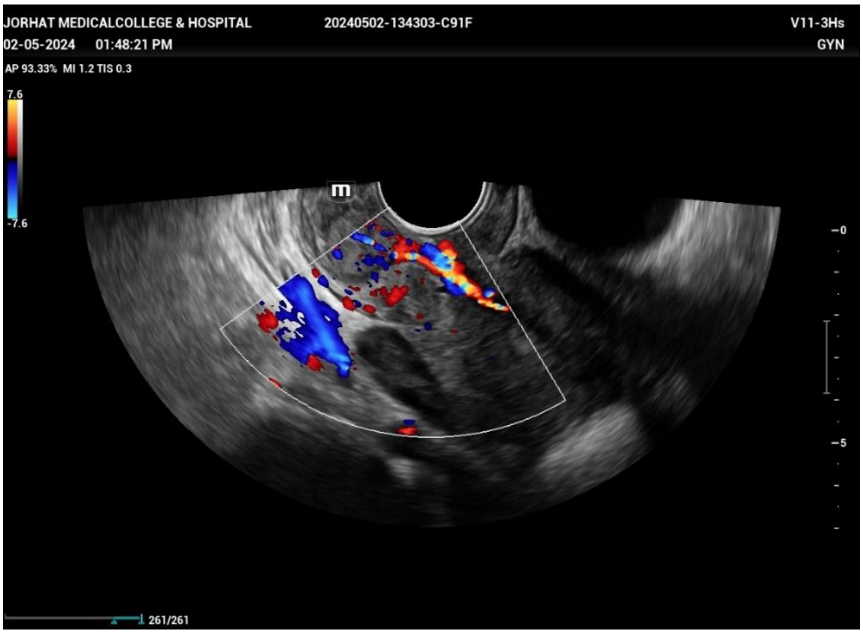

Figure 6(b): Color Doppler imaging showed a stalk-like vascularity called the feeding vessel sign

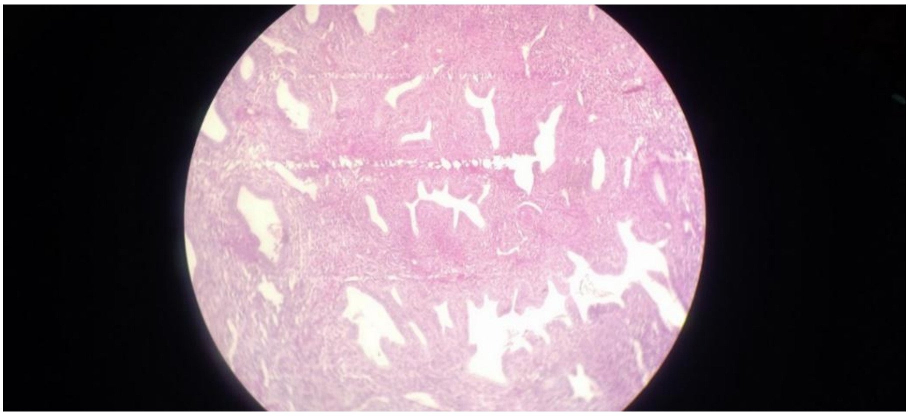

Figure 6 (c): The pathologic examination confirmed the diagnosis of a polyp.

Conflict of Interest

The author declares no conflict of interest.

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