

## Accuracy of Transvaginal Ultrasonographic Diagnosis of Retroflexed Uterus in Endometriosis, with Magnetic Resonance Imaging as Reference

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**Background:** Accurate diagnosis of retroflexed uterus in daily practice is essential because this condition is related to pelvic pain and deep endometriosis. Uterine flexion can be measured by transvaginal ultrasonography (TVUS), a cost-effective primary test, but the accuracy required for diagnosing retroflexed uterus is unclear. This study assessed the accuracy of TVUS for diagnosis of retroflexed uterus in patients with endometriosis and compared it with that of magnetic resonance imaging (MRI)—the gold standard for measuring the uterine axis.

**Methods:** The study included 123 patients who underwent endometriosis surgery in our department between 2012 and 2017. Uterine flexion angles were measured by retrospectively examining TVUS and MRI images, and the correlation was analyzed. Analysis of anteverted and retroverted uterine subgroups identified aspects of diagnosing uterine flexion with TVUS.

**Results:** Uterine flexion angles on TVUS were strongly positively correlated ( $r = 0.86$ ) with MRI results. Additionally, TVUS yielded no false-positive diagnoses and 28 false-negative diagnoses of retroflexion. All false-negative diagnoses occurred in patients with anteverted retroflexed uteruses.

**Conclusions:** TVUS was generally accurate for measuring uterine flexion angle, as indicated by its strong correlation with MRI. Misdiagnosis of anteverted retroflexed uterus was a limitation of using TVUS for retroflexion diagnosis. (J Nippon Med Sch 2023; 90: 26–32)

**Key words:** transvaginal ultrasonography, magnetic resonance imaging, endometriosis, uterine retroflexion

### Introduction

The angles of flexion and version can be used to identify uterine position. The flexion angle, defined as the angle between the uterine body axis and cervix, is normally 90–120° (Fig. 1)<sup>1</sup>. The angle of version, ie, the angle between the uterine cervical and vaginal axes, is normally 70–90° (Fig. 1)<sup>1</sup>. These angles are used to determine if the uterus is anteverted or retroverted and anteverted or retroverted.

Severe dysmenorrhea was found to be associated with uterine retroflexion. The angle of uterine flexion is associated with menstrual pain intensity, especially when the angle between the axis of the uterine body and cervix is  $\geq 210^\circ$ , which indicates severe retroflexion<sup>2</sup>. Therefore, accurate measurement of the uterine angle is important in

assessing preoperative and postoperative symptoms in patients with endometriosis.

Although the retroflexed uterus is a normal physiologic variant present in 20% of women, it is associated with chronic retracting posterior deep endometriosis (DE) and adhesions in endometriosis<sup>3</sup>. Adhesion or closure of the Douglas fossa (cul-de-sac obliteration) is frequently present in DE. These adhesions can complicate surgery and increase the risk of damaging surrounding organs, such as the rectum or ureter. To facilitate complete removal of all DE, intestinal surgery may be required in patients with severe adhesions<sup>4</sup>.

Magnetic resonance imaging (MRI) is the gold standard for diagnosing flexion and version of uterine posi-

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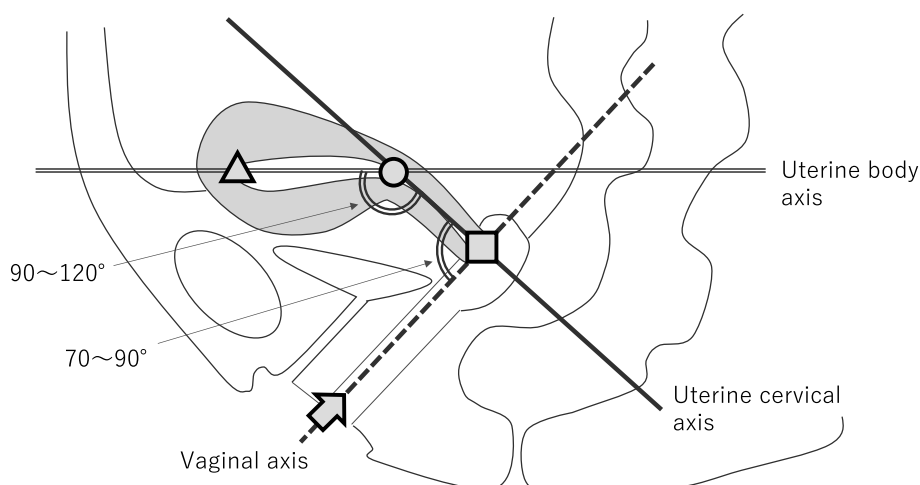


Fig. 1 Median sagittal section of the uterus in the normal position with magnetic resonance imaging (Reprint of Satoru Makinoda: Dislocations of Female Genitals. In: Standard Textbook Series: Obstetrics and Gynecology 4th ed. Igaku-shoin, 2011, p 215. Figure 10-5. In Japanese).

The upper apex of the endometrium is marked with a triangle, and the internal and external uterine ostia are marked with a circle and square, respectively. The vaginal opening is indicated with an arrow. The uterine body axis (double line), uterine cervical axis (single line), and vaginal axis (dotted line) connect them.

tions, because the sagittal view of the uterus can be evaluated objectively. However, an MRI is not easy to perform, primarily because of its high cost<sup>5</sup>.

Transvaginal ultrasonography (TVUS) is a more cost-effective first-line examination for endometriosis and is essential for detecting and predicting endometriosis lesions. TVUS can also be used to diagnose uterine flexion, but its diagnostic accuracy is unclear, particularly because TVUS yields less objective results than MRI and requires sonographic skills and experience. TVUS cannot be used to examine the uterine angle of version because the vaginal probe aligns with the major vaginal axis.

Therefore, we evaluated the accuracy of TVUS and compared it with that of MRI for diagnosis of retroflexion in endometriosis. Additionally, we further classified patients into anteverted and retroverted subgroups and investigated the accuracy of TVUS for diagnosis of retroflexion.

### Materials and Methods

This retrospective observational study analyzed the records of 123 patients with endometriosis who underwent surgery performed by a single surgeon in the Department of Obstetrics and Gynecology, Nippon Medical School Hospital, between 2012 and 2017. A single examiner performed all TVUS scans within 1 month before surgery, and all MRI scans were obtained during the 3 months before the surgery. We excluded patients who

did not undergo both MRI and TVUS within a designated period before surgery. TVUS was performed by using the Voluson E8 system (GE Healthcare, Chicago, IL, USA) and RIC5-9-D transvaginal probe (GE Healthcare).

The present study protocol was approved by the institutional review board of the Nippon Medical School Hospital (No. B-2019-099). All patients provided informed consent to use the examination results for our research.

The uterine body axis is the straight line that runs through the upper apex of the endometrium (indicated by the triangle in Fig. 1) and internal uterine ostium (indicated by the circle in Fig. 1). The uterine cervical axis is the straight line that runs through the internal uterine ostium and external uterine ostium (indicated by the square in Fig. 1). The vaginal axis is the straight line connecting the external uterine ostium and vaginal opening (indicated by an arrow in Fig. 1), corresponding to the vaginal cavity.

The primary outcome data included the angle between the uterine body and cervical axes, uterine antelexion, or retroflexion, as measured by TVUS. We compared these data with those from MRI. Antelexion or retroflexion was evaluated based on the angle between the uterine body and cervical axes in MRI and TVUS scans (Fig. 1). If the angle between the uterine body and cervical axes was  $<180^\circ$  and directed ventrally, it was defined as antelexion. If the angle was  $>180^\circ$  and directed backward,

Table 1 Characteristics of the 123 patients included in the study

	N = 123
Age (mean±SD <sup>a</sup> )	35.6±5.8
Body Mass Index (mean±SD)	20.9±2.7
Nulliparas-Multiparas (cases)	100 (81%)–23 (19%)
CA 19-9 <sup>b</sup> (U/mL, mean±SD)	32.8±177.1
CA 125 <sup>c</sup> (U/mL, mean±SD)	55.1±68.1
History of oral treatment for endometriosis (cases)	38 (31%)
History of surgery for endometriosis (cases)	10 (8%)

a) SD: Standard deviation; b) CA19-9: Carbohydrate antigen 19-9; c) CA125: Cancer antigen

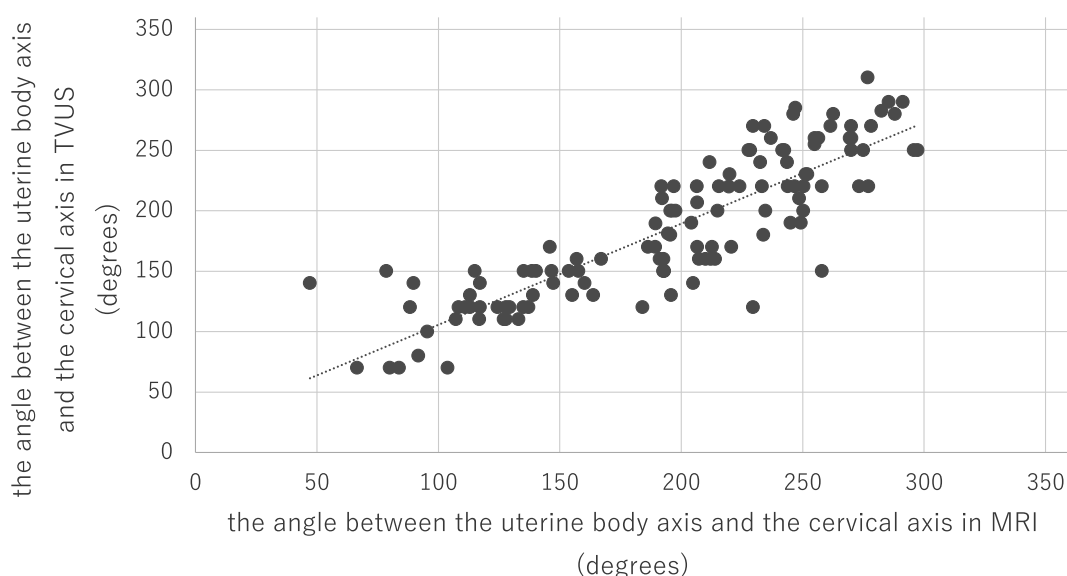


Fig. 2 Distribution of the angle (degrees) between the uterine body axis and cervical axis in magnetic resonance imaging (MRI) and transvaginal ultrasonography (TVUS) in all 123 patients.

it was defined as retroflexion<sup>1</sup>.

Other outcome data included the angle between the vaginal and cervical axes, ie, the version angle. Anteversion or retroversion was evaluated based on the angle in the MRI scan (Fig. 1). If the version angle was  $<90^\circ$ , it was defined as anteversion, and if  $>90^\circ$ , it was defined as retroversion<sup>1</sup>. We excluded patients with side-version, in which the uterus is tilted sideways, and those with MRI scans indicating that the uterine cervix and body were not in the same sagittal plane.

We used the t-test to compare averages of continuous variables and the chi-square test to compare proportions of categorical variables between groups. Pearson product-moment correlation analysis was used for correlation analysis, and statistical significance was defined as a p value of  $<0.05$ . All statistical analyses were performed with Bell Curve for Excel (Microsoft, Redmond, WA, USA).

## Results

The characteristics of the 123 included patients are shown in Table 1. The distribution of the angle between the uterine body and cervical axes on MRI (horizontal axis) and TVUS (vertical axis) in all 123 cases is shown in Figure 2. The correlation coefficient was 0.86, indicating a positive correlation between the two methods.

MRI showed 43 cases (35%) of anteversion and 80 cases (65%) of retroflexion, while TVUS showed 71 cases (58%) of anteversion and 52 cases (42%) of retroflexion. With the MRI diagnosis as reference, all 43 cases of anteversion were correctly diagnosed by TVUS; however, 28 cases (39%) of retroflexion were diagnosed as anteversion (false-negative) by TVUS (Table 2-1). The sensitivity and specificity of TVUS for diagnosing uterine retroflexion are shown in Table 2-2.

When all 123 patients were classified by MRI as anteverted or retroverted, 67 cases were anteverted and 56

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Table 2-1 Details of the diagnoses (cases) obtained using magnetic resonance imaging and transvaginal ultrasound

	Anteflexion using TVUS <sup>a)</sup> 71 cases	Retroflexion using TVUS 52 cases
Anteflexion using MRI <sup>b)</sup> 43 cases	43 (True-negative)	0 (False-positive)
Retroflexion using MRI 80 cases	28 (False-negative)	52 (True-positive)

a) TVUS: transvaginal ultrasound; b) MRI: magnetic resonance imaging

Table 2-2 Diagnostic characteristic index of TVUS diagnosis of uterine retroflexion

Sensitivity	0.65	Specificity	1.00
Positive predictive value	1.00	Negative predictive value	0.61
False-positive ratio	0	False-negative ratio	0.35

Table 3-1 Magnetic resonance imaging characteristics of anteverted uterus group

The anteverted group	Anteflexion using TVUS <sup>b)</sup>	Retroflexion using TVUS
Anteflexion using MRI <sup>a)</sup> 23 cases	23 (True-negative)	0 (False-positive)
Retroflexion using MRI 44 cases	28 (False-negative)	16 (True-positive)

a) MRI: magnetic resonance imaging; b) TVUS: transvaginal ultrasound

Table 3-2 Diagnostic characteristic index of TVUS diagnosis of uterine retroflexion in the anteverted group

Sensitivity	0.36	Specificity	1.00
Positive predictive value	1.00	Negative predictive value	0.45
False-positive ratio	0	False-negative ratio	0.45

Table 3-3 Magnetic resonance imaging characteristics of retroverted uterus group

The retroverted group	Anteflexion using TVUS <sup>b)</sup>	Retroflexion using TVUS
Anteflexion using MRI <sup>a)</sup> 20 cases	20 (True-negative)	0 (False-positive)
Retroflexion using MRI (Retrodeviation) 36 cases	0 (False-negative)	36 (True-positive)

a) MRI: magnetic resonance imaging; b) TVUS: transvaginal ultrasound

Table 3-4 Diagnostic characteristic index of TVUS diagnosis of uterine retroflexion in the retroverted group

Sensitivity	1.00	Specificity	1.00
Positive predictive value	1.00	Negative predictive value	1.00
False-positive ratio	0	False-negative ratio	0

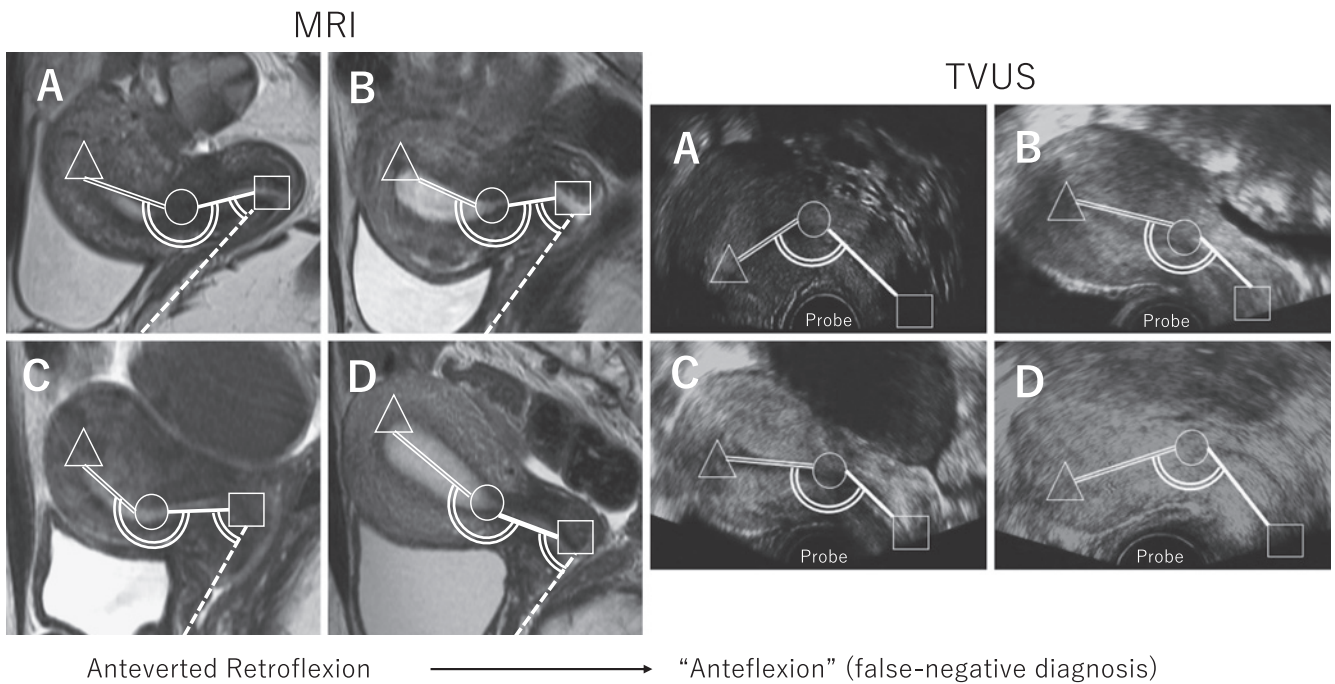


Fig. 3 Median sagittal sections of four representative false-negative cases out of 28 cases of anteverted uterine retroflexion obtained using magnetic resonance imaging (MRI) and transvaginal ultrasound (TVUS).

The upper apex of the endometrium is marked with a triangle, and the internal and external uterine ostia are marked with a circle and square, respectively. The uterine body axis (double line), uterine cervical axis (single line), and vaginal axis (dotted line) connect them.

cases were retroverted. Inconsistency of TVUS in flexion diagnosis, as compared with MRI, was found only in false-negative cases in the anteverted group ( $n = 28$ ) (Table 3-1). TVUS correctly identified all flexions in the retroverted group (Table 3-3).

The sensitivity and specificity of TVUS's diagnostic accuracy of uterine retroflexion are shown in Table 3-2 and Table 3-4.

### Discussion

TVUS is considered accurate for evaluating retroflexion because it correlates strongly with MRI results. To our knowledge, the accuracy of retroflexion diagnosis using TVUS, a cost-effective first-line device, has not been compared to that of MRI, a more objective device. A retrospective study of the accuracy of retroflexion diagnosis suggested that the cervical position observed during speculum examination is important in evaluating uterine anatomy, ie, the angles of the uterus, with TVUS<sup>6</sup>.

Use of TVUS for retroflexion diagnosis in endometriosis is complicated by the presence of anteverted uterine retroflexion (Fig. 4A). In general, retroflexion coexists with a retroverted uterus (or retrodeviation)<sup>1</sup>. Our study of the status of uterine flexion in patients without endometriosis who underwent laparoscopic surgery at our

hospital revealed that uterine retroflexion was present in 20%. All were retrodeviations and were correctly diagnosed as retroflexed by TVUS (data not shown). In the present study TVUS correctly identified all 36 cases of retrodeviation as retroflexion (Table 3-3). However, our study showed that a considerable amount of retroflexion with an anteverted uterus is present in endometriosis patients (Table 3-1), which could be characteristic of endometriosis, because, in our center, all cases of uterine retroflexion without endometriosis were retrodeviations.

Retroflexion could not be correctly diagnosed by TVUS in women with anteverted retroflexed uteruses. Figure 3 shows MRI and TVUS scans of four of the 28 cases of false-negative diagnoses. These misdiagnoses probably occurred because the probe in the anterior vaginal vault can press and shift the cervix, making it appear as if the retroflexed uterus is "anteflexed" (Fig. 4B). This is a limitation of a retroflexion diagnosis using TVUS, especially in women with endometriosis. When the probe is fitted in the posterior vaginal vault, retroflexion was correctly diagnosed by TVUS, even in cases of anteverted uterus (Fig. 4C).

A limitation of this study is that a single examiner performed all TVUSs; therefore, the findings may not be relevant to other examiners. Future studies should at-

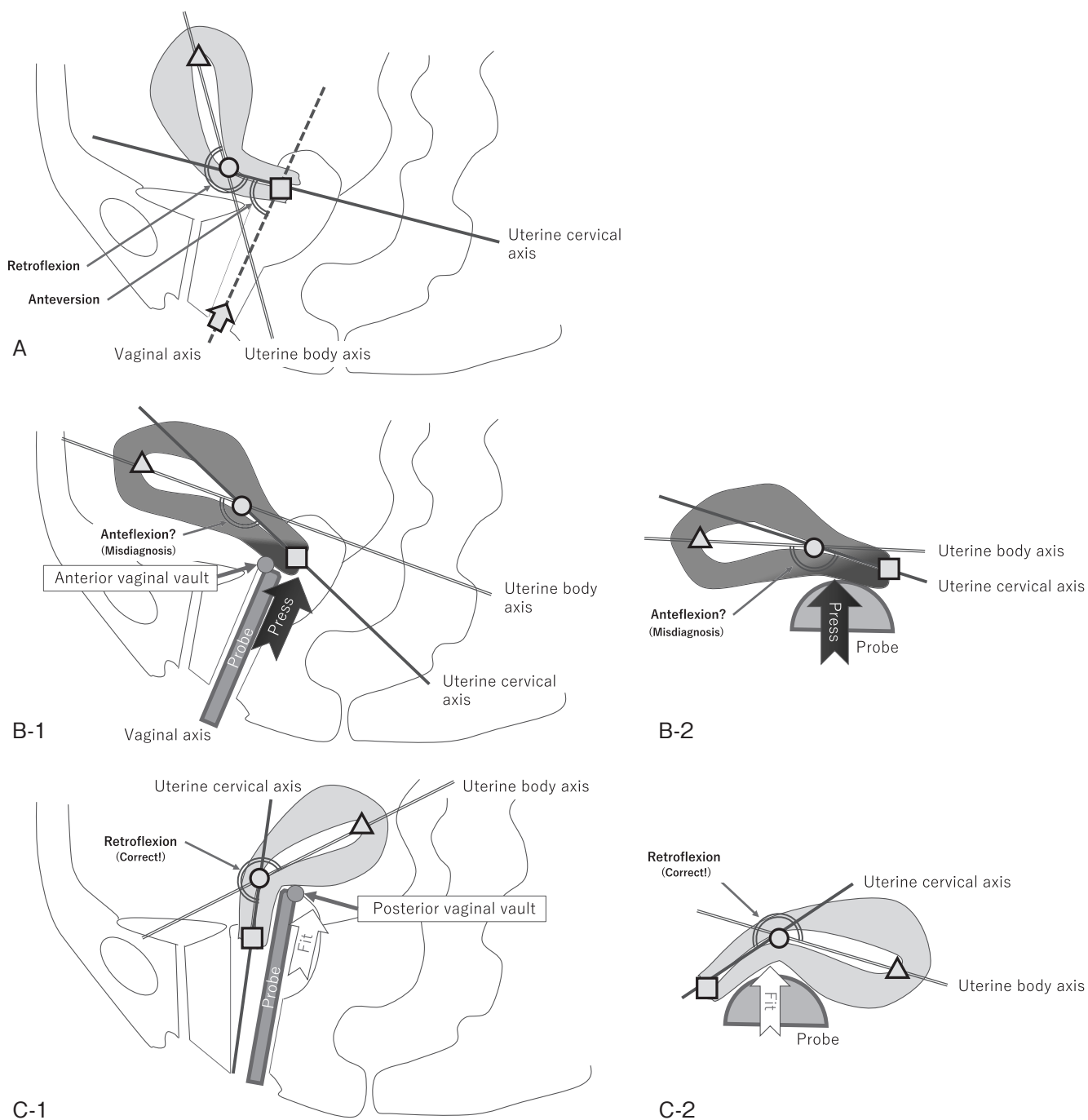


Fig. 4 (A) Description of median sagittal magnetic resonance image of anteverted uterine retroflexion. (B-1) The probe in the anterior vaginal vault shifts the cervix, so that it appears as if the retroflexed uterus is “anteflexed.” (B-2) Description of a view of the uterus with transvaginal ultrasound (TVUS). (C-1) The uterus is correctly shown as retroflexion when the probe fits the posterior vaginal vault. (C-2) Description of a view of the uterus with TVUS.

tempt to verify our findings and evaluate the importance of TVUS. We hope to accumulate more cases, examined by multiple examiners, while carefully monitoring the position of the probe in the vagina.

Our analysis suggests that TVUS is as accurate as MRI for evaluating retroflexion during a first-line examination for endometriosis. All misdiagnoses of retroflexion by TVUS occurred in patients with an anteverted uterus.

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**Conflict of Interest:** Shigeru Matsuda, Masao Ichikawa, Hanako Kaseki, Kenichiro Watanabe, Shuichi Ono, Shigeo Akira, and Toshiyuki Takeshita declare that they have no conflicts of interest.

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