ejpmr, 2017,4(06), 17-25

SJIF Impact Factor 4.161

EUROPEAN JOURNAL OF PHARMACEUTICAL AND MEDICAL RESEARCH

www.ejpmr.com

Research Article

ISSN 2394-3211

EJPMR

ROLE OF VCI –OMNIVEIW (4D ULTRASOUND TECHNOLOGY) IN ACCURATE AND FAST DETECTION OF IUCD COMPLICATIONS

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Article Received on 15/04/2017 **Article Revised on 07/05/2017** **Article Accepted on 29/05/2017**

ABSTRACT

Background and purposes*:* During 2D ultrasound exam of the pelvis we can suspect or partially detect abnormal position of the IUCD but we need a fast ,easy and an accurate technique to accurately diagnose such IUCD complications to deal with it, particularly if the exam was done without specific complain (the most of our patients are referred from the ER department, the most of the referred ER pateints have no symptoms related to IUCD) ,the 3D sonography has two disadvantages , the first one is that the exam is time consuming (time to acquiring a volume of uterus and relatively long time for reconstructing the images through the multiplanar technique, allows visualization of the appropriate sagittal and coronal views),the second disadvantage is that the exam need the operator to be skilled in 3D orientation and subsequent retrieval of the diagnostic planes from acquired volumes. The aim of this work was to demonstrate the significant role of the VCI - omniview 4D application in an accurate and fast detection of IUCD complications and to decrease the requirement of skills from the operator as in the 3D sonography where the operator needs to choose the diagnostic planes from the acquired volume (i.e. omniview VCI technique is a fast and simple technique as compared to the 3D sonography with the same accuracy) **Methods*:*** This observational comparative study was done at Al Salam International Hospital and Al Azhar University Hospitals between June 2013 to December 2016. 74 patients are diagnosed or suspected to have IUCD abnormalities by 2D ultrasound irrespective to their complain, they underwent complementary transabdominal or transvaginal 3D and 4D (3D volume acquisition of the uterus and Omniveiw VCI 3 and 4D technique). **Results*:*** In our study, 4 patients are diagnosed by 2D sonography with no more findings was detected by 3D and 4D sonography however the 3D or 4D omniview VCI sonography is important to confirm the diagnosis and to exclude the presence of other findings, the remaining 70 patients are partially diagnosed or not diagnosed by 2D sonography and accurately diagnosed by other modalities , the same accuracy was obtained by the 3D sonography and the 4D omniveiw VCI sonography however the diagnosis by 3D sonography needs more time , more effort and more operator skills. **Conclusion and Recommendations*:*** The VCI - omniview 4D sonography is practically better than the 3D sonography in detection of IUCD complications inspite of the same accuracy of both techniques due to the VCI - omniview 4D sonography takes less time and less efforts for detection of the findings and also need less operator skills as compared to the 3D sonography.

KEYWORDS: IUCD complications, 3D sonography**,** VCI - omniview 4D sonography.

INTRODUCTION

Various imaging modalities are used in the evaluation of IUCDs. US is appropriate for initial evaluation; it is widely available and inexpensive and does not involve radiation. Furthermore, US can often provide answers to clinical questions related to the IUCD. It easily helps determine whether an IUCD is correctly positioned and can often help identify IUCD-related complications. IUCD displacement and myometrial perforation can be fully evaluated by performing US alone. Three-dimensional (3D) US is often helpful for further characterizing these findings, and its use is becoming standard practice in the routine evaluation of IUCDs.[1]

Types of IUCD

In the United States there are two types of devices available, both are T shaped, made of plastic, have a monofilament tail, and have barium sulfate in the frame to appear radiopaque. One form releases levonorgestrel and is functional for 5 years, and the other form is copper eluting (TCu380A) and is functional for 10 years. The other major class of modern IUCD in mass use is the inert form that is either stainless steel, in use in the China market, or plastic loop with a core of barium sulfate, in use worldwide. Frameless variants of both eluting systems are available. All forms of ICUD in modern use can be assessed by ultrasound.[2]

Normal position

At US, the stem of a properly placed IUCD is straight and is entirely within the endometrial cavity, with the arms of the IUCD extending laterally at the uterine fundus (Fig 1).At evaluation of fundal placement of the IUCD, the distance from the top of the uterine cavity to the IUCD should be 3 mm or less (figure 2).[3] A distance greater than 4 mm is more often associated with symptoms such as bleeding and pain, as well as with a higher risk of expulsion or displacement.[3,4]

Three-dimensional US is also beneficial for determining if the IUCD is entirely within the endometrial cavity (Fig 1).[5] Two-dimensional US is adequate for identifying the stem, but 3D US is often crucial for determining the location of the arms of the IUCD with respect to the uterine cavity.[6] There are also differences in conspicuity between the copper-containing IUCD and the levonorgestrel-releasing IUCD. The echogenic stem and arms of the copper-containing IUCD are seen in their entirety on sagittal and transverse views, respectively. In contrast, the levonorgestrel-releasing IUCD usually manifests with acoustic shadowing between its echogenic proximal and distal ends, so that precise localization is hindered. Both types of IUCDs are more conspicuous at 3D US than at two-dimensional US.[7]

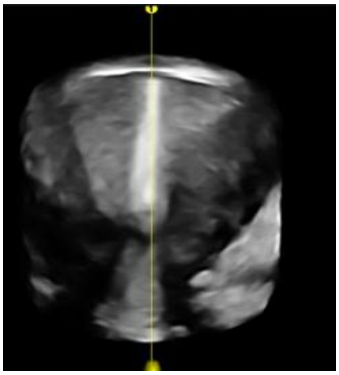

Figure 1: Omniveiw VCI coronal view of the uterine cavity showing a normally located T-shaped intrauterine contraceptive device.

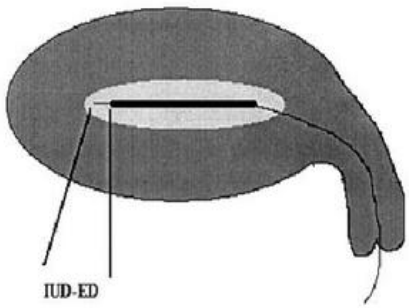

Figure 2: Normal fundal placement of the IUCD with the distance from the top of the uterine cavity to the IUCD 3 mm or less.

Complications

A correctly positioned IUCD should be located at the fundus of the uterus, with the arms fully expanded and extending toward the uterine cornua. The vertical portion of the "T" should extend straight down in the uterine corpus. When noted on US, malpositioned IUCDs may be described as:

1. Displaced IUCD within the uterine cavity Located in the lower uterine segment or cervix.
2. Rotated.
3. Embedded in the myometrium (one or both arms).
4. Partially expelled (if an IUCD is low enough in the cervix that the hub extends through the external os), or completely expelled.
5. Protruding through the uterine serosa or completely outside the uterus and within the abdominal cavity (This is how a perforated or partially perforated IUCD may be described.).

1-Expulsion: A-Partial expulsion; if an IUCD is low enough in the cervix that the hub extends through the external os. B-Complete expulsion; if an IUCD is seen within the vagina outside the uterus

2-Malposition

A-Displacement: Displacement of the IUCD within the uterine cavity.

B-Rotation; Abnormal position of the IUCD with the horizontal limbs oriented or nearly oriented vertically and the stem oriented or nearly oriented horizontally.

3-Impedment: Embedment refers to IUCD penetration into the endometrium or myometrium without extension through the serosa.

3-Perforation

A-Partial Perforation: Refers to IUCD penetration into the endometrium or myometrium with extension through the serosa.

B-Complete Perforation: IUCD is completely outside the uterus within the peritoneal cavity.

4-Retention and Fragmentation: An IUCD left in the uterus for a prolonged period can become encrusted with a fibrous reaction and can be difficult to remove. At times, there can be fragmentation and retention of all or portions of the IUCD.

5-IUCDs and Pregnancy: IUCDs provide highly effective contraception. However, pregnancy does occur in approximately two of every 100 females per year of IUCD utilization. Pregnancy most commonly occurs in the first year of IUCD use.[1]

Omni veiw VCI technique

Volume Contrast Imaging VCI: is a thick slice imaging utilizes volume ultrasound capabilities that

renders from slices in a volume, it has the following criteria:

1- Enhanced contrast and speckle suppression
2- Better assessment of size, margins and internal structures of lesions
3- Improved appearance of physiological structures
4- Enhances contrast through compounding from different angles.
5- Fewer artifacts (shadowing)

OmniView: VCI with selectable thickness, upto 3 planes simultaneously.

OmniView: is the "Any-Plane" function for 3D and 4D data, either real-time or with reloaded cases. Images may be displayed as slice or VCI with selectable thickness, Omni View allows to trace along any shape or structure.

Omniview: recently, improved the results because it can dissect volume along a plane even using curvilinear or irregular cuts; the acceptability of this method provides a new strategy to the study of the uterus.

Aim of the study: The purpose of this study was to demonstrate the significant role of the VCI - omniview 4D application in an accurate and fast detection of IUCD complication and to decrease the requirement of skills from the operator as in the 3D sonography where the operator needs to choose the diagnostic planes from the acquired volume (reducing dependency on the operator's skills) (i.e omniview VCI technique is a fast and simple technique as compared to the 3D sonography with the same accuracy) .

PATIENTS AND METHODS

This observational comparative study was done at Al Salam International Hospital and Al azhar University Hospitals between June 2013 to December 2016.

A GE voluson E8 and voluson 730 pro ultrasound systems equipped with (4D probe), a 1-5 Mhz trans-abdominal transducer and 5-9 trans-vaginal transducer was used.

The IUCD was considered abnormally located if it is displaced, rotated or any part of it was seen to extend past the confines of the endometrial cavity, poking into the substance of the uterus or cervix.

74 patients are diagnosed or suspected to have IUCD abnormalities by 2D ultrasound irrespective to their complain, they underwent complementary transabdominal or transvaginal 3D and 4D sonography.

The exam of the uterus was made by 3D(volume acquisition of the uterus), 3and 4D (omniview scan) to identify IUCD position.

The IUCD demonstrated on 2D ultrasound by visualization of its shaft (sagittal view of the uterus) followed by:

1-3D (volume acquisition of the uterus) as following

The volume box is superimposed, the volume mode is switched on and the 3D ultra-sound is generated by the automatic rotation of the mechanical transducer. Three perpendicular planes are displayed simultaneously (sagittal, axial, coronal) thus enabling better understanding of the endometrial cavity. Evaluation of the stored volumes depends on the number of slices, rotation angle and rendering modes used. Since the number and orientation of reformatted planes are not limited, meticulous evaluation of numerous sections through the cavity becomes possible. From the stored images, a plastic image of the cavity and of its content, as well as surface rendering can be obtained. The surface rendering allows exploration of the outer wall of the cavity.

2- 4D (omniview scan) as following

The desired line (with a selected direction and angle to become parallel to the shaft of the IUCD) is superimposed upon the IUCD shaft then the volume mode is adjusted (according to the desired slice thickness) and switched on and the 4D ultra-sound is generated. Coronal plane of the uterus is displayed showing the IUCD position, if the horizontal limbs are not seen properly, the slice thickness ,direction and angle can be changed to quickly evaluate the horizontal limbs.

RESULTS

74 patients are diagnosed or suspected to have IUCD abnormalities by 2D ultrasound were included in this study.

Two of these patients (2.7%) with retained IUCD fragments (Figure 3) within the endometrium and myometrium are seen and partially diagnosed by 2D sonography , the 2D suspect the presence of retained fragment however the sure diagnosis and dedicated orientation to their anatomical location(the endometrial or myometrial location) only achieved by 3D and 4D omni view sonography of the fragment ,moreover less time and less experience was needed by the omniview 4D sonography (because there is no need for postprocessing as the 3D sonography and no need for high grade operator skills because the omniveiw technique is a simple technique as previously described).

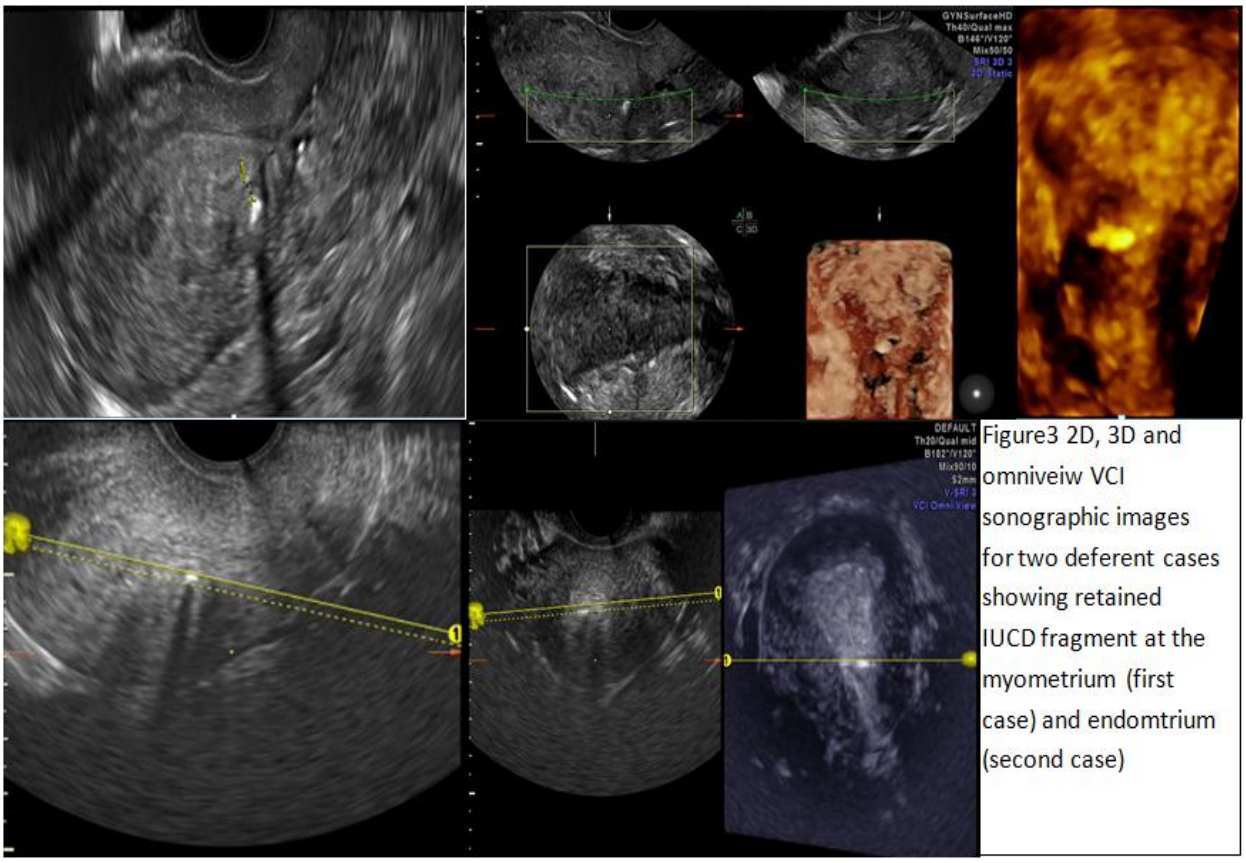

Figure3 2D, 3D and omniveiw VCI sonographic images for two deferent cases showing retained IUCD fragment at the myometrium (first case) and endomtrium (second case)

Four of these patients (5.4%) showing IUCD and gestational sac within the uterus are seen in 2D sonography however the relation and orientation of the IUCD and the sac are achieved by the 3D and 4D omni view sonography (4D omni view sonography is better than 3D sonography due to the same previously described reasons).

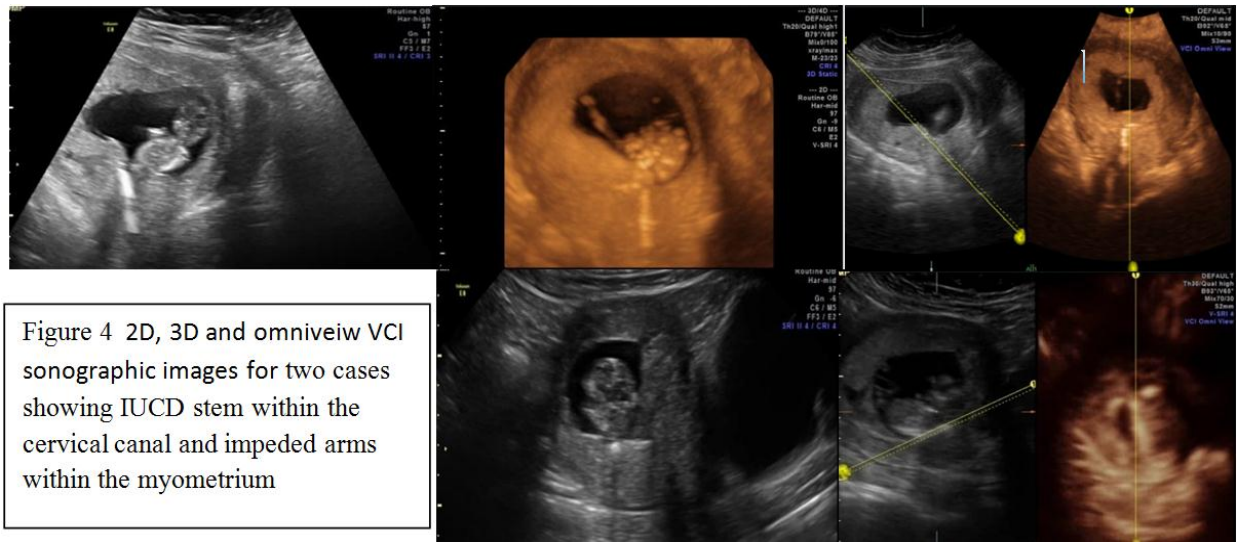

Figure 4 2D, 3D and omniveiw VCI sonographic images for two cases showing IUCD stem within the cervical canal and impeded arms within the myometrium

Six of these patients (8.1%)showing uterine scar of previous C. sections and IUCD within the uterus and the 2D sonography suspect a some sort of scar penetration by IUCD stem however the 3D and 4D omniview sonography exclude the possibility of scar penetration(4D omniview sonography is better than 3D sonography).

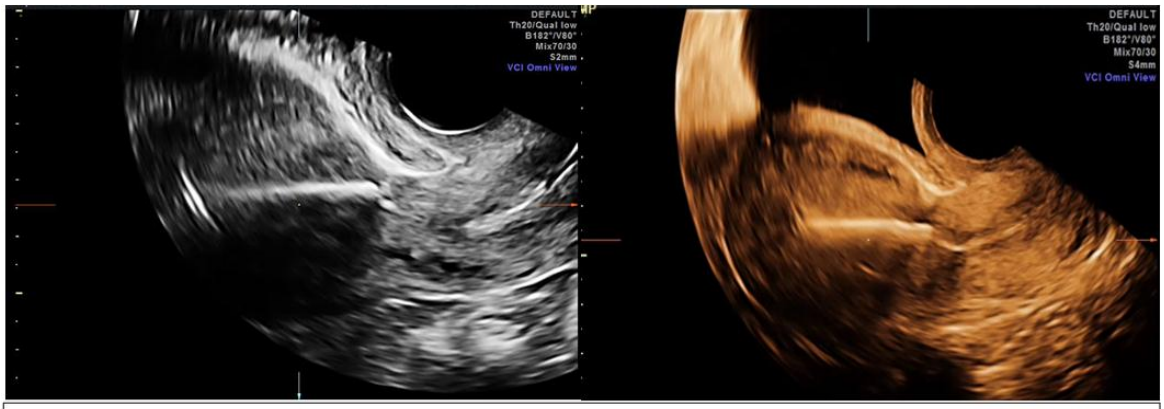

Figure 5 omniview VCI sonographic images for a two cases with previous CS showing no evidence of IUCD penetration to the scar.

Four of these patients (5.4%) showing displaced IUCD at the lower uterine segment and upper cervix are seen and diagnosed in 2D, 3D and 4D omniveiw sonography however dedicated orientation to their anatomical location only achieved by 3D and 4D omniview sonography (4D omniview sonography is better than 3D sonography).

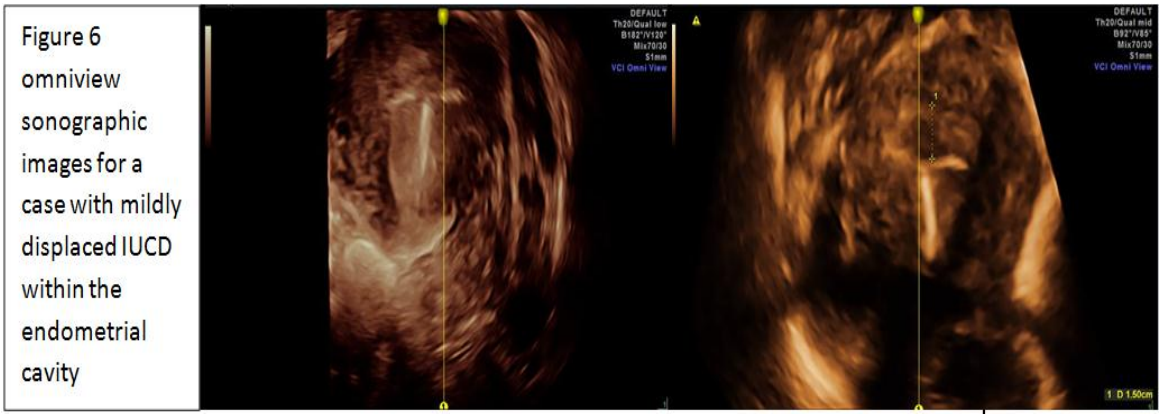

Figure 6 omniview sonographic images for a case with mildly displaced IUCD within the endometrial cavity

Eight of these patients (10.8%) showing the IUCD within the uterine cavity by 2D sonography however their abnormal orientations (they are rotated with the IUCD stem oriented or nearly oriented horizonally and the limbs oriented vertically or nearly oriented vertically) only detected by the 3D and 4D omniview sonography (4D omniview sonography is better than 3D sonography).

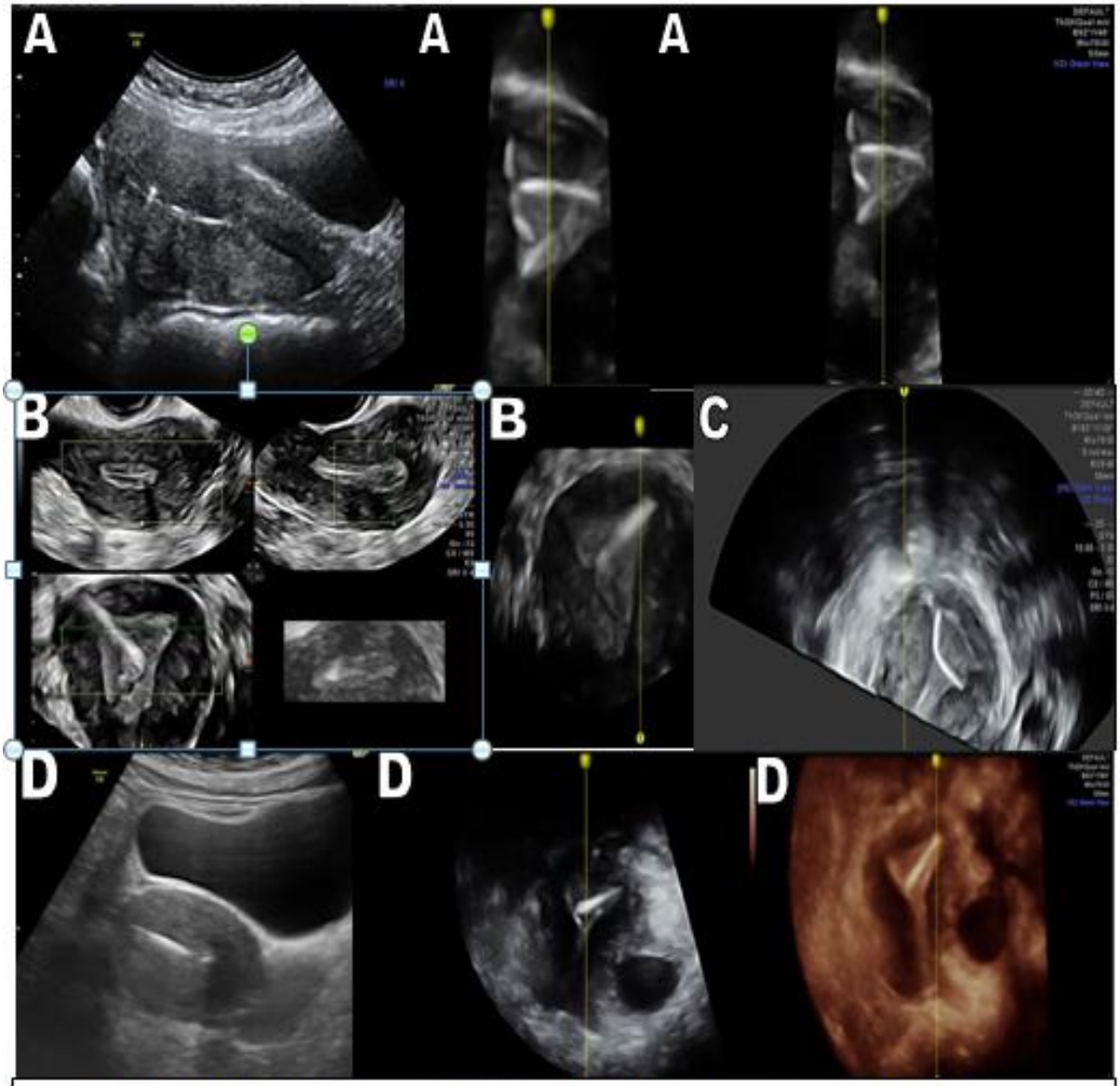

Figure 7 2D,3D and omniveiw VCI sonographic images for a four cases with abnormally rotated IUCD within the endometrial cavity , first ,second and fourth cases images (A ,B and D) display misdiagnosis of the IUCD rotation in 2D images and clearly portrayed in 3D and omniveiw VCI images ,The third case image (C) displays slightly rotated IUCD with one of its arms seen migrating into the proximal segment of one of both fallopian tubes

Fifty of these patients (67.6%)shows malpositioned IUCD (rotated and /or displaced at the lower uterine segment / upper cervix) with impeded one or two horizontal IUCD arms within the myometrium, the IUCD displacement is noted at the 2D sonography however the rotation and impedment is only seen at the 3D and 4D omniview sonography (4D omniview sonography is better than 3D sonography).

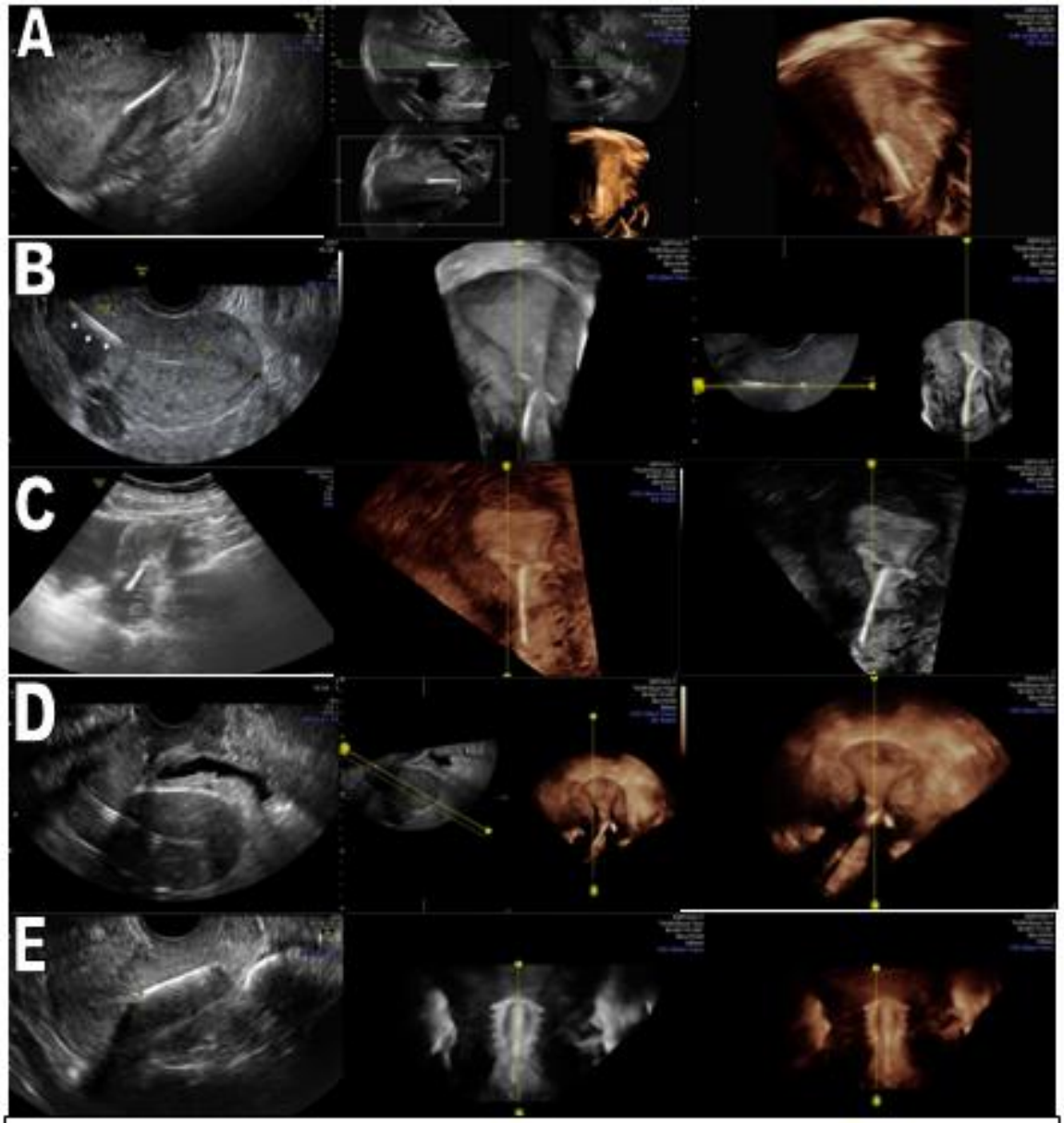

Figure 8 2D,3D and Omniveiw VCI sonographic images for a five cases with malpositioned and impeded IUCD , the 1st case (A) shows rotated IUCD with mildly impeded one IUCD arm which cannot be seen at the 2D image , the other four cases (B,C,D and E) show displaced IUCD with impeded one or both IUCD arms .

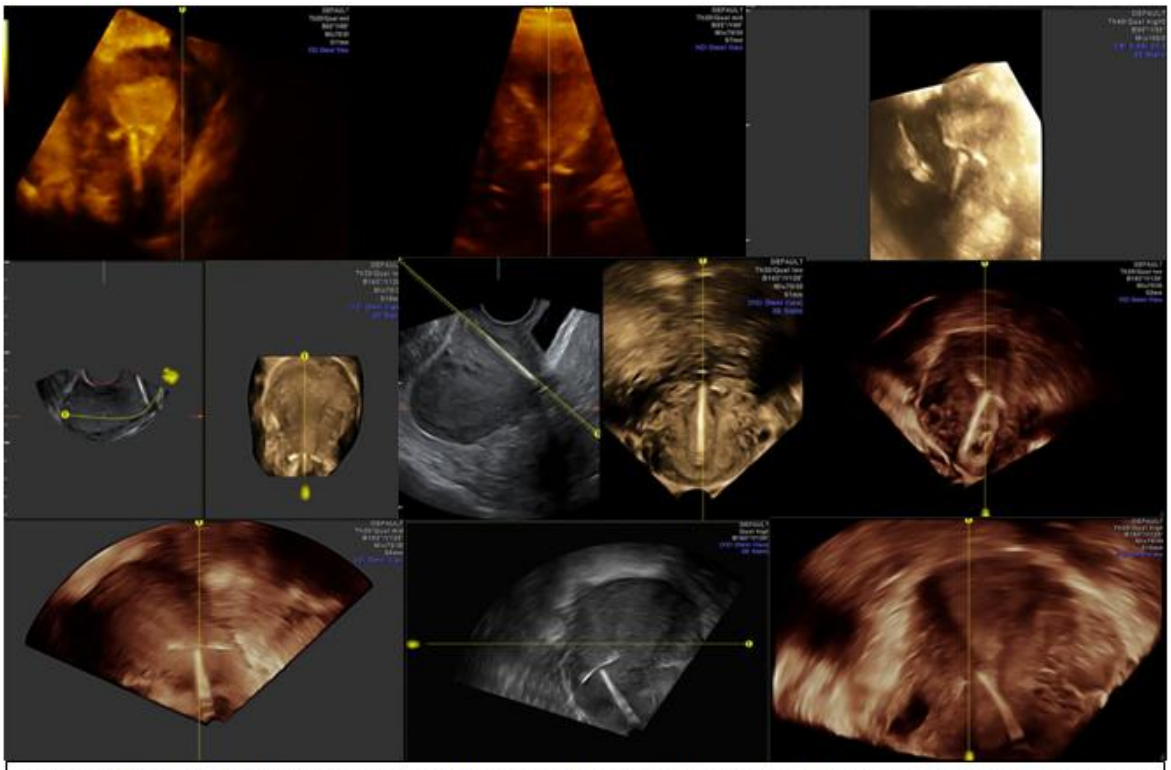

Figure 9 3D and Omniveiw VCI sonographic images for multiple cases with displaced and impeded one or both IUCD arms.

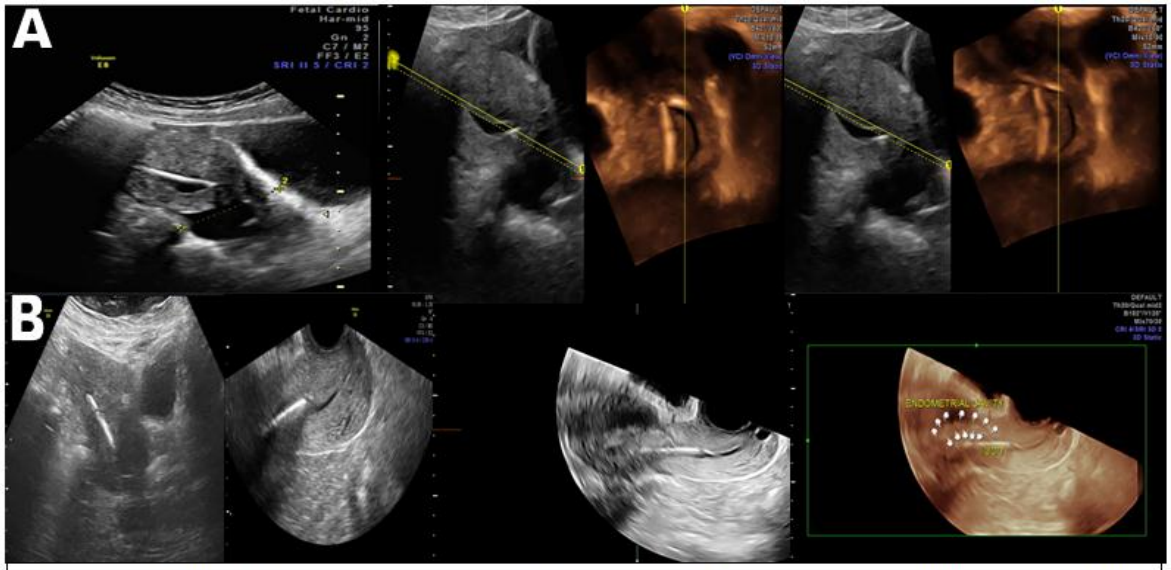

Figure 10 2D,3D and Omniveiw VCI sonographic images for a two cases with markedly impeded IUCD within the myometrium and misdiagnosed by the 2D images to be inplace, the 1st case (A) shows completely impeded IUCD within the myometrium parallel to the endometrial cavity that containing fluid rim , the second case (B) shows impeded arms and most of the IUCD stem within the myometrium apart from short segment of the stem seen within the endometrial cavity near the internal cervical os

(Table 1) Number of cases that diagnosed by each sonographic modalities (2D, 3D and VCI Omniview 4D sonography

Table 1	Cases diagnosed by 2D sonography	Cases diagnosed by 3D sonography	Cases diagnosed by VCI Omniview 4D sonography
2 Cases with retained IUCD fragement (100%)	0 (0%)	2 (100%)	2 (100%)
4 Pregnant cases on IUCD(100%)	0 (0%)	4 (100%)	4 (100%)
6 Cases with scar Of prevaious CS , relation of the scar to the IUCD (100%)	0 (0%)	6 (100%)	6 (100%)
4 Cases with IUCD displacement (100%)	4 (100%)	4 (100%)	4 (100%)
8 Cases with IUCD rotation(100%)	0 (0%)	8 (100%)	8 (100%)
50 Cases with IUCD impedment and malposition (100%)	0 (0%)	50 (100%)	50 (100%)

DISCUSSION

The 3D ultrasound is an accurate method for diagnosis however it needs a time for acquisition a volume of data and a relatively long time for processing such a volume of data. Also the accuracy of the 3D sonography will depend upon the operator skills. Omniview VCI - 4D technique is a novel algorithm that overcomes the disadvantages of the 3D sonography because it needs very short time for acquisition and no need for postprocessing the acquired volume of data like the 3D sonography . Other advantage of such algorithm that it improves the results because it can dissect a volume along a plane even using curvilinear or irregular cuts[8,9] so the Omniview VCI - 4D technique provides a new strategy to study all structures that not clearly identified by the 2D exam with less time, less dependency on operator skills when compared to the 3D sonography.

During 2D sonography of the pelvis we can suspect or detect abnormal position of the IUCD but an accurate diagnosis of such abnormality cannot be achieved by 2D in most patients so we need a fast ,easy and an accurate technique to accurately diagnose such IUCD complication to deal with it ,the 3D sonography need a time to acquiring a volume of uterus and then, by subsequently reconstructing the images, allows visualization of the appropriate sagittal and coronal views (postprocessing steps) and also the 3D sonography need the operator to be skilled in 3D orientation and subsequent retrieval of the diagnostic planes from acquired volumes.

Omniview VCI - 4D technique can be used to visualize standard coronal planes of the uterus showing the IUCD immediately (no need for processing the acquired volume of data) and clearly (less dependency on operator skills when compared to 3D sonography).

The purpose of this study was to demonstrate the significant role of the VCI - omniview 4D application in an accurate and fast detection of IUCD complication and to decrease the requirement of the operator to choose the diagnostic planes from the acquired volume as in 3D sonography (reducing dependency on the operator's skills).

Our study involves 74 patients that diagnosed or suspected to have IUCD abnormalities by 2D ultrasound and most of them are discovered accidentally, so we need a fast and an accurate complementary exam to clearly diagnose this additional accidentally discovered problem, the 3D sonography will take a time and need high grade skilled operator for postprocessing the volume of data, consequently the Omniview VCI - 4D technique achieved our goals.

Four of these patients (5.4%) are diagnosed by 2D sonography and the remaining 70 patients (94.6%) are

not clearly seen by 2D and accurately diagnosed by other modalities.

The patients that are diagnosed by 2D sonography needs to be confirmed by the 3D or Omniview VCI - 4D sonography.

As regarding the application of the Omniview VCI technique as a new 3D and 4D sonographic software, and according to our study we detect that.

This method differs highly from tomographic ultrasound imaging in which volume data sets are automatically sliced and displayed in multiple images because this pictorial essay shows that 3D imaging by OmniView is technically easy compared with previously reported 3D techniques; that OmniView allows visualization of all of the anatomic landmarks of a specific targeted area[10] this novel technique is easy and feasible, requires a limited learning curve, and provides correct volume interrogation of the region of interest. The OmniView algorithm may be useful in training programs, and volume data sets can be interpreted by experts in remote sites.[10]

The possibility to apply 3D ultrasound to stored multiplanar analysis of an anatomic volume has been demonstrated. Omniview, recently, improved the results because it can dissect volume along a plane even using curvilinear or irregular cuts; the acceptability of this method provides a new strategy to the study of the uterus.[11]

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