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RESEARCH ARTICLE

Infertile Patients Undergoing Non-Contributory three-Dimensional Multidetector CT Hysterosalpingography

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ABSTRACT:

Background: In order to identify the structural causes of infertility in women, imaging is a prevalent health issue that must be treated. For uterine, tubal, and peritoneal variables, the three-dimensional multi-detector computed tomography hysterosalpingography (3D-MDCT-HSG) procedure offers a simple workup. The capabilities of multidetector CT are combined with the well-established method of hysterosalpingography to create the novel, noninvasive modality known as virtual hysterosalpingography, which enables simultaneous, non-invasive evaluation of the entire uterine wall, uterine cavity, cervix, and Fallopian tubes. A key benefit of the operation, which can be used as an alternative diagnostic method in the infertility workup algorithm, is the evaluation of the para-uterine pelvic tissues. With the reconstruction of two-dimensional, three-dimensional, and virtual endoscopic views, virtual hysterosalpingography enables a thorough assessment of the female reproductive system with just one imaging test. It also provides accurate anatomical information and a thorough characterization of the various pathologic processes.

Aim: The aim of the study was to assess the spectrum of uterine, tubal, and peritoneal factors on 3D-MDCT-HSG and determine its diagnostic accuracy for female factor infertility.

Material and Method: The Department of Radiology conducted the study, which was prospective. This study included 25 participants who were infertile. With no HSG contraindications, the women were assessed on days 7 through 10 of their menstrual cycle. Each diagnostic test was interpreted by a different radiologist in a blinded manner with relation to the following: Presence of any lesion causing infertility. The lesion's type and location. Fallopian tube health. After the final diagnosis was made, the radiologist analyzed the MDCT VHSG images and reexamined the X-ray images before creating a reference final result (X- ray). An enhanced reference final result was produced using this procedure.

Results: The sensitivity for uterine pathology, fallopian tube pathology, and per-patient pathology of MDCT VHSG was 100%, yet of X-ray, HSG was 89%, 100%, and 86 tube% respectively. Where specificity for uterine pathology, fallopian tube pathology, and per-patient pathology of MDCT VHSG was 100%, 92%, and 90% respectively, and of X-ray HSG was 92.3%, 85%, and 79% respectively. PPV for uterine pathology, fallopian tube pathology, and per-patient pathology of MDCT VHSG was 100%, 90%, and 92% respectively whereas o -ray HSG was 89%, 84%, and 86% respectively.

Conclusion: Imaging studies play a significant and important part in the diagnostic and therapeutic steps involved in the evaluation of infertile women; VHSG has the capacity to integrate the majority of the benefits of the diagnostic methods, making it a useful tool for the gynecologist in the evaluation and treatment of the infertile woman. Whether it should be used in place of typical conventional HSG entirely in cases of infertility in females, or just as a backup, and when suspicious or abnormal findings are found.

Keywords: Female factor, Hystero-laparoscopy, Hysterosalpingography, Infertility and CT

Introduction

For society, infertility represents a significant financial and health cost. Its incidence in various parts of India is believed to range from 3.9 to 16.8 percent.[1] Every sixth couple on the planet is sterile.[2] Both anatomical and functional variables may be to blame, with uterine, fallopian tube, and peritoneal

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factors each accounting for one-third of instances as anatomical causes. Hence, to identify the precise morphological reason causing female infertility, a thorough and accurate imaging of the path-anatomy of the female reproductive canal is needed.[3] There is a desire for female infertility imaging to increase in tandem with the rapidly expanding infertility services market.[4] The quality of two- and three-dimensional reconstructions, as well as the virtual endoscopic evaluation of smaller structures, have significantly improved over the past ten years due to the multi-detector computed tomography technology's rapid growth. Volumetric data acquisition, which is made possible by isotropic imaging quality with high spatial, temporal, and contrast resolution, was made possible by this advancement.[5,6] Using diagnostic imaging techniques, the uterus and Fallopian tubes are often evaluated using ultrasound, conventional hysterosalpingography (HSG), and magnetic resonance imaging.[7] The examination of the heart, colon, and airways has been transformed by the development of multidetector computed tomography equipment with an ability for unusually high spatial and temporal resolution.[8] The capabilities of multidetector CT are combined with the well-established method of hysterosalpingography to create the novel, less invasive modality known as virtual hysterosalpingography (VHSG), which enables simultaneous evaluation of the entire uterine wall, uterine cavity, cervix, and Fallopian tubes. An excellent benefit of the process that might be used as an alternative diagnostic method in the evaluation of infertility is the evaluation of the para-uterine pelvic structures.[9]

A better voxel profile is ensured by the advent of 64-row CT scanners, which provide isotropic spatial resolution, thinner collimation, improved picture quality, as well as temporal and contrast resolutions.[10] One of the main objectives in the evaluation of patients who are infertile is the visualization and assessment of the fallopian tubes, which is significantly improved by all of these characteristics.[11] Multidetector CT's excellent spatial resolution and selection of post-processing techniques provide more accurate characterisation of raised lesions of various sizes than is even achievable with hysteroscopy.[6] A new hybrid technique called three-dimensional multi-detector computed tomography hysterosalpingography (3D-MDCT-HSG) uses an MDCT to image the peritoneal spill as well as the uterine and tubal lumen that have been filled with contrast. As CT is more sensitive to contrast, it is better able to see the contrast-filled tubes without the issues of peritoneal spill, inadequate opacification from reflex cornual spasm, or overlapping or obstruction of tubes as in HSG.[12,13] When thin slices are acquired, post-processing can produce multiplanar reformatted (MPR) pictures that can be used to assess the uterus's exterior contour. An additional benefit that enables the identification of the peritoneal factor is the non-invasive assessment of the peri-tubal and peritoneal region.[6,14]

MATERIAL AND METHODS

The Department of Radiology conducted the study, which was prospective. This study included 25 participants who were infertile. With no HSG contraindications, the women were assessed on days 7 through 10 of their menstrual cycle. Each diagnostic test was interpreted by a different radiologist in a blinded manner with relation to the following: Presence of any lesion causing infertility. The lesion's type and location. Fallopian tube health. After the final diagnosis was made, the radiologist analyzed the MDCT VHSG images and reexamined the X-ray images before creating a reference final result (X- ray). An enhanced reference final result was produced using this procedure. Each procedure's length, level of patient discomfort, and radiation dose were noted, and comparisons between the two methods were made with relation to these factors. Patients who agreed to participate in the trial with their guardians' permission provided signed informed consent.

The technique of the MDCT virtual hysterosalpingography

MDCT virtual hysterosalpingography was obtained using 64-row MDCT (Toshiba aquilion 64 V3.30ER003) with the following technical parameters: collimation: 64 · 0.5 mm; slice thickness: 0.5 mm; reconstruction interval: 0.3 mm; average scan time: 4 s; 120 kV; 120–200 mAs; rotation time: 0.55 s; mean patient effective dose: 3.54 ± 0.6 millisievert (mSv). The patient was lying supine in the lithotomy position on the CT table. The vagina was dilated with a speculum after the perineum was cleaned with a povidone-iodine solution, and the cervix was also cleaned. A scout view of the pelvis was then obtained with the speculum in situ. In order to reduce unnecessary huge fields of view and excessive radiation exposure, the localizer was changed to localize a tiny field of view. Then, without cervical clamping, a specially made plastic cannula was inserted into the external cervical OS, and 10–20 ml of diluted (1–5 mL contrast agent diluted with 9–15 mL saline solution) nonionic, low osmolar contrast media were slowly injected into the cervical canal to prevent the uterus from expanding too quickly and potentially injuring the patient. The average scan time for the MDCT VHSG after contrast injection was 4s.

Post-processing tools

Original CT data were transferred to a workstation and then reprocessed using many processing tools such as; maximum intensity projections (MIPs) which created images similar to conventional HSG by increased thickness of the slab, and multiplanar

reconstructions (MPR) in coronal, sagittal, oblique and curved images to unfold the uterus and improve visualization of the uterine cavity and cervical canal, also Virtual endoscopic images could be created which showed the lumen of the uterus, cervix, and fallopian tube, in addition to three-dimensional volume rendering reconstructions which facilitated visualization of the uterine external contour

The technique of the X-ray hysterosalpingography

The MDCT VHSG was followed up with an X-ray HSG using a Dinan 1000 X-ray unit the same day or the following day. On the radiology fluoroscopy table, the patient was set up in the lithotomy position. The perineum was cleaned with a povidone-iodine solution, and the cervix was also cleaned with a povidone-iodine solution, and then a sterile speculum was placed into the vagina. A single-toothed tenaculum was put to the cervix's anterior lip while the cervical region was clamped. The HSG was carried out after inserting the metal cannula into the cervix. The injection of 10–20 mL of water-soluble iodine-contrast material was followed by spot radiographs and radioscopy until the diagnosis was made. Radiographs of four to five spots were taken at 70-90 kV and 12-16 mAs. A scout radiograph was taken first. The second spot radiograph was then taken after the dye was slowly injected to prevent rapid uterine expansion and the discomfort of the patient, and to allow for early images to be obtained before the dye entered the peritoneal cavity, allowing for better evaluation of the uterine cavity and fallopian tubes. A questionnaire describing the level of discomfort experienced during the procedures was given to the patient after she had had both procedures (G0 no discomfort, G1 mild discomfort, G2 moderate discomfort, and G3 severe discomfort). Both the duration of the examination for both procedures and the patient's effective dose were recorded. A total of 25 patients were analyzed by MDCT-HSG, and uterine and peritoneal variables were assessed in each case since two women had uteruses that had been eaten by unicorns.

STATISTICAL ANALYSIS

SPSS version 20 statistical software was used to examine the data. The findings and diagnoses for the various uterine and peritoneal variables were expressed as percentages per 25 patients. The percentage of tubes used to represent fallopian tube discoveries. Hystero-laparoscopy results were compared with MDCT-HSG results, and diagnostic accuracy was determined using contingency tables. Findings were given as sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) for various parameters and specific diseases (when possible) (NPV).

RESULT: -

Twenty-five female patients with the diagnosis of infertility underwent both MDCT VHSG and X-ray HSG. No adverse events occurred during both procedures.

Table 1: Summary of radiologic findings by X-ray HSG and MDCT VHSG, and the ultimate diagnosis made by reference final.

Radiologic finding		N	%	N	%	N	%
Uterine pathology	Positive	12	48.0	10	40.0	12	48.0
	Negative	13	52.0	17	64.0	13	52.0
Fallopian tube pathology	Positive	12	48.0	13	52.0	11	44.0
	Negative	13	52.0	12	48.0	14	56.0
Per patient examination	Positive	15	60.0	15	60.0	14	56.0
	Negative	10	40.0	10	40.0	11	44.0

The mean patient age was 25.11 ± 4.5 years. Of the 25 patients studied, 10 (40%) showed normal results by the reference final result. Pathologic findings based on the reference final result were as follows: uterine pathology (n = 12) and fallopian tube pathology (n = 12); and the detailed pathologies which were: submucosal myomas (n = 1); uterine synechiae (n = 1); uterine malformations (n = 7); right hydrosalpinx (n = 1); left hydrosalpinx (n = 3); right tubal obstruction (n = 7); left tubal obstruction (n = 7) and ovarian cyst (n = 2)

Table 2: Diagnostic value of X-ray HSG and MDCT VHSG for uterine pathology, fallopian tube pathology, and per-patient pathology.

	Uterine pathology		Fallopian tube pathology		Per patient pathology	
	X-ray HSG (%)	MDCT VHSG (%)	X-ray HSG (%)	MDCT VHSG (%)	X-ray HSG (%)	MDCT VHSG (%)
Sensitivity	89	100	100	100	86	100
Specificity	92.3	100	85	92	79	90
PPV	89	100	84	90	86	92
NPV	92.3	100	100	100	79	100

The sensitivity for uterine pathology, fallopian tube pathology, and per-patient pathology of MDCT VHSG was 100%, yet of X-ray, HSG was 89%, 100%, and 86 tube% respectively. Where specificity for uterine pathology, fallopian tube pathology, and per-patient pathology of MDCT VHSG was 100%, 92%, and 90% respectively, and of X-ray HSG was 92.3%, 85%, and 79% respectively. PPV for uterine pathology, fallopian tubes pathology, and per-patient pathology of MDCT VHSG was 100%, 90%, and 92% respectively whereas of X-ray HSG was 89%, 84%, and 86% respectively, while NPV for uterine pathology, fallopian tubes pathology, and per patient pathology of MDCT VHSG was 100%, 100%, and 100% respectively, whereas NPV of X-ray HSG was 92.3%, 100%, and 79% respectively.

Table 3: Number and percentage of patients exhibiting different discomfort grades during both X-ray HSG and MDCT VHSG.

Grade of discomfort	X-ray HSG	MDCT VHSG
No discomfort	0 (0%)	9 (36%)
Mild discomfort	8 (32%)	5 (20%)
Moderate discomfort	10 (40%)	11 (44%)
Severe discomfort	7 (28%)	0 (0%)

The mean radiation dose of X-ray HSG and MDCT VHSG was 5.10 ± 0.2 mSv and 2.47 ± 0.4 mSv respectively, with a significant radiation dose reduction of 2.59 ± 0.3 mSv in MDCT VHSG when compared with X-ray HSG. The median grade of patient discomfort during X-ray HSG (with cervical clamping) was 2(1–3), and during MDCT-VHSG (without cervical clamping) was 1(0–1) with a significant reduction in patient discomfort grade.

DISCUSSION

A total of 25 individuals were chosen based on non-contributory HSG, and these patients underwent MDCT-HSG, which revealed clear imaging results and established an MDCT-HSG diagnosis for 23 patients. In 23 out of 25 (95%) individuals where the anatomical etiology for female infertility could be established, MDCT demonstrated superiority to conventional HSG.

Infertility-causing female variables can appear alone or in a variety of combinations. Only one infertility factor was present in seven patients, two in nine, and all three was present in five women. These three infertility factors include uterine, tubal, and peritoneal. Therefore all three uterine, tubal, and peritoneal variables can be assessed with MDCT-HSG in a single scenario. The most prevalent gynecological condition, pelvic inflammatory disease (PID), may be the cause of the high tubal block incidence (60%) in our study.[15]

According to Carrascosa et al.[5], the MDCT VHSG was suggested as an alternative non-invasive diagnostic method for the examination of the female genital tract. The 64-row MDCT's volumetric and isotropic CT data enabled a precise virtual endoscopic examination of the uterus, cervix, and fallopian tube. In comparison to the standard X-ray HSG, the MIPs, MPRs, and three-dimensional volume rendering reconstructions in combination with virtual endoscopic views of the endoluminal structure provided an accurate evaluation of various female reproductive tract anomalies. The ampullary segment is wider than the isthmic segment, which has been compared to the appearance of a spaghetti noodle. The placement of the tubes within the pelvis varies significantly naturally, therefore an odd location does not always indicate a tubal problem. Virtual hysterosalpingography provides a clear representation of frequent anomalies such as tubal blockage and stenosis brought on by postoperative complications or infection. When the tubal patency is normal, contrast material can be observed easily leaking into the peritoneal cavity.[14]

After enlarging the uterine cavity with CO2, Takeda et al.[16] and Akaeda et al.[17] created virtual endoscopic images by 16-row MDCT to investigate the patient with submucous myoma before hysteroscopic myomectomy. There is a need to compare the diagnostic usefulness of the virtual endoscopy produced by MDCT after injecting diluted contrast media with hysteroscopy as opposed to the evaluation of MDCT VHSG as compared to traditional X-ray HSG that was the emphasis of the literature. For the detection of uterine fibroids and congenital uterine abnormalities, MDCT-HSG showed a diagnosis accuracy of 100%. All four metrics—specificity, NPV, and PPV—were 100%. The most frequent abnormality identified by other authors and present in 42.85% of patients was an arcuate uterus.[18,19] The uterus was convincingly portrayed in the reformatted images, preventing misinterpretations that could happen in an HSG without additional views. A fundal cleft that can be seen on MPR imaging can assist medical professionals identify between a bicornuate and a septate uterus. A further benefit over other imaging techniques for making a precise diagnosis is the ability of MDCT-HSG to evaluate the exterior contour in addition to the uterine cavity. The spatial interactions of the uterus with other pelvic tissues can be better understood with the help of 3D-MDCT-HSG. The findings of our investigation agreed with the available literature in this regard.[5]

CT performs better in delineating the fallopian tubes because it is more sensitive to detecting contrast. The reason for the better results of 31.8% on MDCT-HSG as opposed to 18.2% on traditional HSG was a better understanding of the contrast-filled tubes. Axial CT images also assist in separating tubes from spilled contrast where there is uncertainty.[14] Similar to the causes of tubal blockage, previous surgery, infection, or inflammation can result in peritubal adhesions. In terms of diagnosing peritubular adhesions, the sensitivity and negative predictive values of MDCT-HSG were superior (83.3% and 92.3%, respectively) to the specificity and positive predictive values (75.5% and 55.5%, respectively). According to Karasick et al.[20], who also came to the same conclusion that ampullary dilatation in non-occluded tubes cannot be dependably used to determine the diagnosis of peritubular adhesions, all patients who showed false positive results displayed ampullary dilatation with contrast spill.[20]

using hysteroscopy to inject diluted contrast material. The benefits of the MDCT VHSG technique include the ability to evaluate various pelvic structures as well as the lumen of the female reproductive system using non-invasive virtual endoscopy, making it a comfortable and safer procedure with a low radiation dosage to the patient. The main drawbacks of this treatment are the expensive cost of the examination, the lack of a plastic cannula, and the MDCT VHSG examination. The study's limitations included the study's relatively small patient population, the absence of intravenous contrast, and the use of a foley's catheter with an inflated bulb in the cervix, which prevented examination of the cervical canal.

CONCLUSION:

Imaging studies play a significant role in the assessment of infertile women and significantly advance the diagnostic and therapeutic steps involved in the process; VHSG has the capacity to integrate the majority of the diagnostic methods' benefits, making it a useful tool for gynecologists in the assessment and care of infertile women. Whether it should be used in place of typical conventional HSG entirely in cases of infertility in females, or just as a backup, and when suspicious or abnormal findings are found. Complete morphological evaluation of the female reproductive tract's anatomy and evaluation of all three components of infertility with an anatomical reason are made possible by 3D-MDCT-HSG. It performs well in identifying uterine and tubal infertility causes, but its application to peritoneal factors is restricted. This is a very helpful method that uses a small amount of radiation and exhibits early results that are encouraging, even in patients with non-diagnostic HSG.s

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