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## IDENTIFICATION OF FALLOPIAN TUBES USING THE NEW NON-CONTRAST ULTRASONIC TECHNIQUE "THE MOBILE HYDRO ACOUSTIC WINDOW"

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**Summary.** *The objective was to design and to evaluate the sensitivity of the non-contrast ultrasound technique of "mobile (hydro) acoustic window" (MHAW) which could be used during the routine transvaginal ultrasound (TVS) for improvement to visualize of pelvic objects. It has been demonstrated that the use of non-contrast ultrasound MHAW-technique during the routine transvaginal ultrasound is an effective diagnostic method for assessing the anatomical and some functional characteristics of the fallopian tubes in female infertility. The MHAW- ultrasound technique is very convenient and informative when there is doubts the fallopian tubes anatomy or functionality. However, it should be emphasized that the method requires a special skills from the sonographer. The sensitivity of MHAW-technique may be less for women with some individual ultrasonic and anatomical features of pelvic organs and tissues. The obtained information may have a crucial importance if choosing the optimal algorithm for the infertile couple when suspicions of altered anatomy arise. The MHAW-technique provides a good opportunity for both anatomical and functional of the fallopian tubes evaluation the fimbrio-ovarian relationship and tubal ovum pick-up including. MHAW is easy and affordable ultrasound technique which can be used in cases of unexplained infertility.*

**Keywords:** *transvaginal ultrasound, TVS, TVUS, MHAW, mobile hydroacoustic window, Female infertility, unexplained infertility, Fallopian tubes, Fimbria, paratubal cyst, PTCs, oocyte capture, ovum pick-up, fimbrio-ovarian relationship, tubal functionality.*

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### Introduction

TVS is the first-line test became one of the cornerstones laying in the foundation of the development of Reproductive Medicine - Chizen D.R., Pierson R.A. (2010) [1]. Nevertheless, the abilities of TVS are limited due to the insufficient wave transmission of ultrasonic signal by the transducers with the high frequently and resolution. The main properties of the signal depend on its reflection by the tissues at the interface of solid and liquid media. So strengthening the effect can improve the image quality of the scanned object. The use of the effect of full bladder during abdominal ultrasound was an excellent solution, which opened the broad prospects for the development of the method. Rare works reported the cases of non-systematic visualization of the unaltered fallopian tubes during TVS. Timor-Tritsch JE, Rottem S, 1987 [2], Asim Kurjak, Frank A Chervenak, 2003 [3], pointed on the possibility of identifying fimbriae of fallopian tubes visualized in free fluid surrounding the ovary following ovulation or HSG [1-3]. Nevertheless, we did not encounter any reference to the evidence base and methodology of non-contrast ultrasonic identification of fallopian tubes with the normal anatomy, as well as about the possibilities for description the details of the ultrasound structure of the unaltered fallopian tubes. The correct assessment of the functional state of the Fallopian tube will be useful in management of infertile couple. It is important not only for the natural conception optimization, but also for the correct choice of treatment methods, such as intrauterine insemination or laparoscopy [4, 5, 6]. Moreover, information about unaltered Fallopian tubes can be very valuable for prognostic purposes. The visual assessment of oviducts is useful if we need obtain the information of the spatial fimbrio-ovarian relationship [7].

**Objective:** To design the new non-contrast ultrasound technique of "mobile hydroacoustic window" (MHAW) to improve possibilities of routine transvaginal ultrasound and to evaluate its sensitivity.

### Materials and methods

The MHAW - technique: The sufficient amount of fluid to create the "mobile hydroacoustic window" can be detected at different periods of the menstrual cycle.

Explication of the fig. 1: VU (vesicouterine) fluid level; SU - ligament uterosacral; RU (rectouterine) pouch; RUP fluid level - fluid level in the rectouterine pouch; RV (rectovaginal) pouch; Fossa ovary fluid level.

Initially, the sonographer performs a routine TVS, determining the position, structure, dimensions of a uterus, ovaries and other pelvic organs. The next task is to create MHAW. You can use the fluid any origin that was accumulated in low spaces of pelvis. Usually we use the pelvic fluid which appeared following ovulation. The careful palpation through the abdominal wall with physician's free hand can help to "push out" the omentum or bowel loops from the area of "MHAW" to increase the size and improve visualization through the window. Once the researcher sees the object fragment e.g. fimbriae he should try to gently move transducer along the object and make the next attempt to increase the MHAW size. If you fix the scanning head of transducer in the depth of the pelvis after recently occurred ovulation, the fluid may accumulate around the probe and the MHAW could increase. Sometimes, for increasing the MHAW is not necessary to move a transducer into the depth, just pull slightly the transducer while rotating. The volume of fluid, which we can use to create the effective MHAW for searching the separate fimbria, is starting from 0,5 cm<sup>3</sup>. However, with the increase of the MHAW fluid volume we can identify not only small details but one or two adjacent parts of the fallopian tube (see at Fig. 2). If the funnel with fimbriae is located far away from the MHAW - it might be problematic to identify the object irrespective of the fluid volume used to create the MHAW. Also it may be a problem for this Fallopian tube functionality. Ultimately, visualization quality of an object

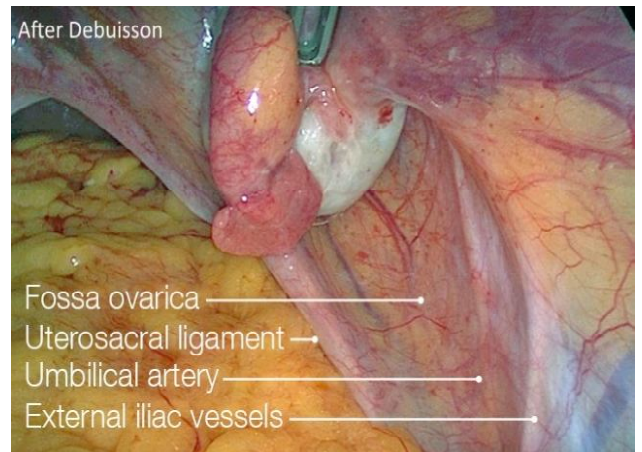
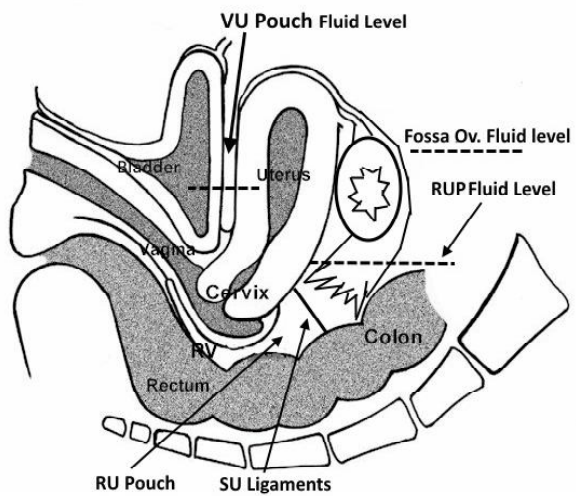


Fig. 1. Anatomical and ultrasound landmarks in the MHAW-technique.



Fig. 2. The echograms with the images of tubal parts: the ampoules, the funnel and fimbriae. MHAW-technique.

depends largely on its topography and ultrasound properties of pelvic tissues, rather than only from the size of MHAW.

The examination with the MHAW-technique is beginning within the recto-vaginal space (RV see Fig. 1).

Scanning the fallopian tubes in the MHAW-technique should be started with the cervix uteri sagittal sections to use it as a suitable topographical landmark and first place where the fluid will appear. Rectovaginal space is the lowest place in the pelvis where the fluid is concentrated. It is expedient to scan the external uterine contour area moving along the posterior wall. If the uterus is anteverted and sufficient amount of fluid is available, some fimbriae of oviduct may be visualized in the anterior Douglas' pouch (VU, see at Fig. 1). Frequently the separate fimbriae can identify close the loops of bowel in such cases. During the examination it is important that the head of the scanning transducer's will be placed within the MHAW. One of the main anatomical and ultrasound landmarks of the fallopian tubes is ligament uterosacral (SU, see at Fig. 1). You can identify most elements of the distal end of the fallopian tube such as funnel or fimbriae closely from this ligament (Fig. 3).

The ovarian fossa filled with the fluid is shown in the

above picture. For this reason, ligament uterosacral free fluid surrounds is often visualized as a bright line or a curve (Fig. 3). The ligamentum uterosacral could be considered as kind of "balcony railing", which separate the fossa ovary and Douglas' pouch. On these echograms the ovarian fossa is completely covered with fluid. In such cases, we can only see this ligamentum, but we cannot identify the surface of ovarian fossa. If the ovarian fossa covered with fluid only partially the sonographer could visualize its surface as shown on the next picture (Fig. 4).

On the sonogram provided above (on the left) the ligamentum uterosacral smoothly comes into the ovarian fossa. The best conditions for the identification of the infundibulum fimbriae occur in close proximity to the ovarium of the anteverted uterus. The ovary is a principal landmark of distal tube parts. In the vicinity of the ovaries we can often identify an ampule of the fallopian tube, the funnel and fimbriae (see at Fig. 5). The tube angle (uterine cornuae) of uterine body is a suitable region for visualization of its intramural (interstitial) portion. Scanning should be carried out from the oviduct proximal towards the utero-tubal junction and the distal end. The fimbriae can only be definitively



Fig. 3. Ligamentum Uterosacral. MHAW-technique.

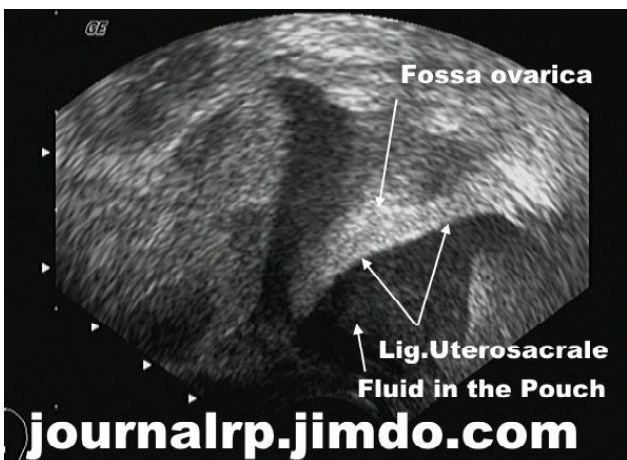


Fig. 4. Echograms of the ovarian fossa and ligaments uterosacral. MHAW-technique.

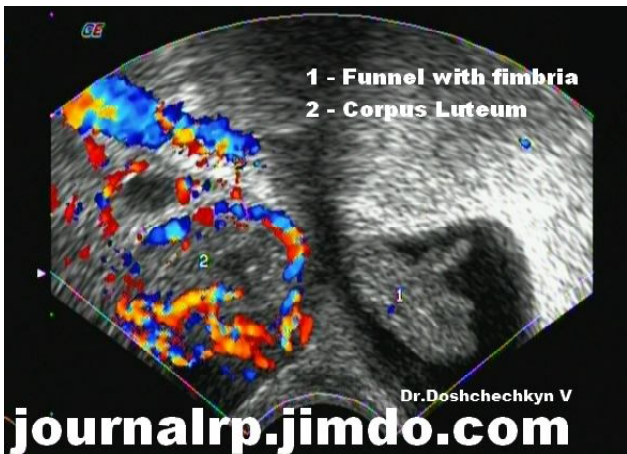


Fig. 5. Ovary is the next marker of the distal end of oviduct. MHAW [8].

distinctly identified when free fluid surrounds the funnel. The oviduct and fimbriae are easily visualized within a fluid pocket following ovulation. It may be difficult, or impossible, to visualize the Fallopian tube when loops of bowel distended with gas or intestinal contents are located between the ultrasound probe and tube.

It is often more difficult to visualize the left adnexa, especially if a woman has a high BMI, as fat lining bowel

impairs ultrasound wave transmission [1] We notice, the imaging of left side is impaired when the uterus is acutely rotated clockwise. However, a systematic scan of the Fallopian tubes proximally from the uterine cornuae, parallel to mesosalpingeal vessels, and distally around the ovaries will ensure visualization the entire tube length [1] (Fig. 5, 6).

If paratubal cysts (PTCs) are identified it is suggested to specify their type, location and vessels (see Fig. 7). The most



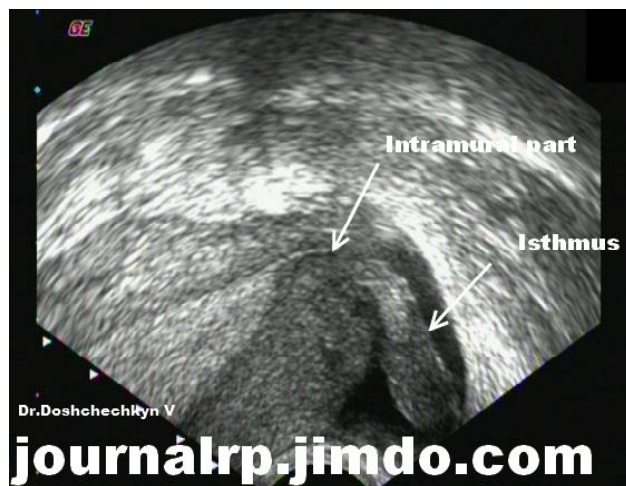


Fig. 6. Echograms of tubal uterine body angle with the interstitial portion of the fallopian tube. MHAW-technique.



Fig. 7. Morgagni's Hydatid localized close the funnel can interfere on the ovum pick-up mechanism. MHAW-ultrasound technique.

common PTCs are the remnants of embryonic ducts: Koblert's cyst, Morgagni (hydatid) cyst, Müllerian cyst, etc. The paratubal cysts are specific indicators of the distal end of the Fallopian tube. They are frequently related with the infundibulum and fimbria by adhesions.

The presence of PTCs, adhesions, extension or constrictions of isthmus, rigid fimbriae etc. could have a negative effect to the fallopian tubes ovum pick-up. In opposite: The wide funnels, isthmus normal shape and outer diameter, the presence of significant amounts of well differentiated flexible fimbriae, located near the ovary apex, were seen as a positive functional assessment for ovum pick-up. While usually asymptomatic, has been noted that Morgagni's cysts tend to be more common in women with unexplained infertility (52,1% versus 25,6% in controls). Rasheed S.M., Abdelmonem A.M. (2011) [9]; Cebesoy F.B. et al. (2010) [10] suggested that they can play a role in infertility. It has been proposed that these cysts interfere with tubal functionality and egg pick-up. Timely detection and removing of this pathology provides a chance for recovery of female fertility [9, 10].

The study was carried out between November 2014 and February 2015 with the aim of anatomical and functional assessment of the fallopian tubes in infertile women. The

fallopian tubes were examined by the two ultrasound techniques. The TVS procedure was performed in the MHAW-technique amongst 87 women with infertility were included in the main group. In the control group of 60 infertile women there were undergoing TVS in its routine version in order to monitor ovulation. The average duration of infertility in the main group was  $2,4 \pm 0,4$  years and  $2,5 \pm 0,5$  years - in the comparison group. In groups there were no significant differences in age and BMI. The average number of ultrasound examinations was the same in both groups- 2,0. It was determined the sensitivity of the new method for the anatomical and functional assessment of the tubal landmarks. The width of the funnel, extension or constrictions of the isthmus, flexibility of fimbriae, their quantity and differentiation, adherent PTCs were considered as ultrasound landmarks for the anatomical and functional assessment of the Fallopian tubes. All examinations were carried out by the same physician with the standard micro convex vaginal probe 4-9 MHz.

### Results. Discussion

The comparison of two versions of the transvaginal ultrasound showed the following (Table 1).

The application of MHAW-technique has significantly increased the frequency of detection of Fallopian tubes in

**Table 1.** Patients who have been identified fallopian tubes.

	TVS+MHAW	%	TVS	%
Patients	n 87		n 60	
Fallopian identified	28	32,2	4	6,7

**Table 2.** The ultrasound findings have been discovered due the identification of the Fallopian tubes in the both groups.

Group	Main		Comparison	
	TVS+MHAW	%	TVS	%
Identified findings:	n 87		n 60	
Normal proximal end	5	5,7	NA	NA
Normal fimbriated end	26	29,9	3	5,0
Dilatation or constrictions	6	6,9	4	6,7
Paratubal cysts (PTCs)	18	20,7	5	8,3
Adhesions	14	16,1	3	5,0

women of main group, in comparison with the standard TVS. The Fallopian tubes have been identified with TVS + MHAW procedure in 28 women (32,2%) of the main group. The oviducts were visualized in 6,7% of subjects in comparison group (TVS).

Thus, sensitivity of new method was 0,76 versus 0,14 for routine TVS. The next ultrasound findings related with oviducts were identified (Table 2).

The application of MHAW-technique during a routine TVS significantly increased frequency of identification of various parts of the fallopian. Significantly more in the study group one or both fallopian tubes were identified simultaneously. Moreover, the isthmus, ampoule, fimbriae, the adhesions related with fimbriae and PTCs have visualized more frequently. Also, the distal parts, which play an important functional role in the mechanism of oocyte pickup and fimbrio-ovarian relationship, were observed significantly more than proximal. However were no significant differences in the frequency of detection of dilated and pathologically altered tubes in both groups?

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With the increase of size of MHAW not only small details but one or two adjacent parts of the fallopian tube were identified. Yet, when the funnel with fimbriae was located far away from the MHAW - was a problematic to identify the object irrespective of the fluid volume used to create the MHAW. We can assume if the zone of interest" of Fallopian tube is controlled with the "dry" oviducts - the oocyte capture function of this uterine tube is not optimized. In such cases the tubal pick-up option with the "dry" oviduct in fact is preserved only at the moment of the extrusion of the follicle contents. If could not find the fluid in pelvic sacs following ovulation, it means the distal ends of oviducts are in the "dry" zone. Apparently, this is not the best option for conception, but to understand how much this is can be important for ability to conceive, it is necessary to undertake further epidemiological research based on the proposed MHAW- ultrasound technique

**Conclusion and the prospects of the further researches**

1. The use of MHAW-technique during the TVS is advised in the management of unexplained infertility for assessment of the anatomical and functional properties of the Fallopian tubes. This is important to obtain the information for the purpose of selecting the optimal algorithm for the infertile couple management.

2. Also, the use of ultrasound MHAW-technique during TVS represents a good opportunity for the topographic evaluation and respectively for the functional assessment of the fimbriae-ovarian relationship. This work is one more attempt to find an explanation of reasons for the decline of tubal competence.

The further studies could be associated with the functional and epidemiological assessment of fimbrio-ovarian relationship and search for the best ways to solve the problem of the decline of fallopian tubes functionality

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**Дощечкин В.В.**

**ИДЕНТИФИКАЦИЯ ФАЛЛОПИЕВЫХ ТРУБ С ПОМОЩЬЮ НОВОГО НЕКОНТРАСТНОГО УЛЬТРАЗВУКОВОГО ИССЛЕДОВАНИЯ "МОБИЛЬНОЕ ГИДРОАКУСТИЧЕСКОЕ ОКНО"**

**Резюме.** Исследование было направлено на разработку нового неконтрастного ультразвукового метода диагностики с использованием эффекта "Мобильного гидроакустического окна" (МГО) во время трансвагинального ультразвукового сканирования (ТВС) с целью идентификации трудно визуализируемых объектов малого таза. Осуществлена оценка чувствительности нового метода. В работе были продемонстрированы преимущества ультразвуковой техники МГО при использовании ее во время проведения ТВС. Результатами признана целесообразной практика применения метода в диагностике бесплодия неясного генеза для получения информации об анатомических и функциональных особенностях интактных маточных труб и паратубарных кист, влияющих на фимбрио-яичниковые взаимоотношения. Такая информация важна при выборе оптимального алгоритма лечения бесплодной супружеской пары, например, проведения внутриматочной инсеминации или же лапароскопии при подозрении на измененную анатомию маточных труб. Кроме того, использование ультразвуковой техники МГО во время ТВС, представляет собой хорошую возможность для топографической и функциональной оценки компетенции фаллопиевых труб и состояния фимбрио-яичниковых отношений.

**Ключевые слова:** трансвагинальное УЗИ, ТВС, ТВУС, эхография, женское бесплодие, паратубарные кисты, трубный фактор бесплодия, мобильное гидроакустическое окно, МНAW, МГО, диагностика бесплодия, фимбрио-яичниковые взаимоотношения.

**Дощечкин В.В.**

**ИДЕНТИФІКАЦІЯ ФАЛЛОПІЄВИХ ТРУБ ЗА ДОПОМОГОЮ НОВОГО НЕКОНТРАСТНОГО УЛЬТРАЗВУКОВОГО ДОСЛІДЖЕННЯ "МОБІЛЬНЕ ГІДРОАКУСТИЧНЕ ВІКНО"**

**Резюме.** Дослідження було спрямоване на розробку нового неконтрастного ультразвукового методу діагностики з використанням ефекту "Мобільного гідроакустичного вікна" (МГВ) під час трансвагінального ультразвукового сканування (ТВС) з метою ідентифікації важко візуалізуючих об'єктів малого тазу. Здійснено оцінку чутливості нового методу. В роботі були продемонстровані переваги ультразвукової техніки МГВ при використанні її під час проведення ТВС. Результатами визнана доцільною практика застосування методу в діагностиці безпліддя неясного генезу що до отримання інформації про анатомічні та функціональні особливості інтактних маткових труб і паратубарних кіст, які мають певний вплив на фімбріо-яєчникові взаємовідношення. Така інформація важлива при виборі оптимального алгоритму лікування безплідної подружньої пари, наприклад, при проведенні внутрішньоматкової інсемінації або ж, навпаки - лапароскопії при підозрі на порушену анатомию маткових труб. Крім того, використання ультразвукової техніки МГВ під час ТВС, являє собою гарну можливість для топографічної та функціональної оцінки компетенції фаллопіїєвих труб і стану фімбріо-яєчникових відносин.

**Ключові слова:** трансвагінальне УЗД, ТВС, ТВУС, ехографія, жіноче безпліддя, паратубарні кісти, трубний фактор безпліддя, мобільне гідроакустичне вікно, МГВ, МНAW, діагностика безпліддя, фімбріо-яєчникові взаємини.

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**КЛІНІЧНИЙ ВИПАДОК ВІДЕОТОРАКОСКОПІЧНОГО ВИДАЛЕННЯ НОВОУТВОРЕННЯ СЕРЕДОСТІННЯ**

**Резюме.** На прикладі клінічного випадку пухлини передньо-верхнього середостіння продемонстровані безпечність та ефективність методу відеоторакоскопічного видалення новоутворень середостіння, а також варіабельність новоутворень середостіння та їх ембріо- та гістогенетичну різноманітність.

**Ключові слова:** мініінвазивна хірургія, торакоскопія середостіння, клінічний випадок.

**Вступ**

Проблема лікування хворих онкоторакального профілю на сьогодні продовжує залишатись провідною проблемою клінічної онкології. Пухлини середостіння є одним з найбільш складних розділів у торакальній хірургії та онкології, оскільки вони походять з різнорі-

дних тканин, а об'єднання їх у цю групу базується лише за ознакою спільності анатомічних меж. До новоутворень середостіння відносять тімоми (епітеліальна, лімфоепітеліальна, лімфоїдна, веретенноклітинна, гранулематозна, неklasифікована) (31%), герміногенні