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Comparison of Four Dimensional Transvaginal Sonography Versus Hysteroscopy in Assessment of Abnormal Uterine Cavity in Infertile Women

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ORIGINAL ARTICLE

Comparison of Four-dimensional Transvaginal Sonography Versus Hysteroscopy in Assessment of Abnormal Uterine Cavity in Infertile Women

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Abstract

Background: **Transvaginal ultrasonography in four-dimensions (TVS 4D) is a novel imaging method. It can visualize surfaces in three-dimensions and concurrently register all three imaging planes.**

Aim and objectives: **To correlate the accuracy of Transvaginal four-dimensional ultrasound (TV4D US) versus Hysteroscopy in assessment of abnormal uterine cavity in infertile women.**

Patients and methods: **This study was a prospective, comparative, observational study that involved 100 infertile females who underwent hysterosalpingography and/or conventional vaginal ultrasonography to diagnose their uterine intracavitary lesion or abnormality was conducted at Al-Azhar University Hospitals.**

Results: **Regarding US, the most prevalent finding was polyp (38%) followed by myoma (21%). Meanwhile, there was 16% of the patients were in normal US. Regarding hysteroscopy, only 4 patients were normal while 42% were polyp and 23% were myoma.**

Conclusion: **The four-dimensional transvaginal ultrasonography can be utilised to diagnose uterine focal lesions with outcomes in comparison with hysteroscopy. The greatest benefit of hysteroscopy is that it allows for surgical intervention in the same location, making it the gold standard diagnostic and therapeutic technique for uterine anomalies (bicornuate, septate, arcuate, and polyp). Only a diagnostic tool, 4D ultrasonography is superior to hysteroscopy in several lesions, such as (subserous and intramural fibroid). Gives more benefit in more precise measurement of the size, consistency, and vascularity, which is not always visible in hysteroscopy. Intrauterine adhesions and endometrial polyps, however, are harder to diagnose.**

Keywords: Abnormal uterine cavity, Four dimensional transvaginal sonography, Hysteroscopy, Infertile

1. Introduction

About 2–3% of women with reproductive failure have abnormal uterine findings. It is necessary to evaluate the uterine cavity because of the high percentages of benign anomalies, which are assumed to be linked to poor endometrial receptivity.[1]

Several methods can be used to evaluate the intrauterine structure, including: two dimensional transvaginal sonography (TV2D), sonohysterography, hysterosalpingography (HSG), three dimensional transvaginal sonography (TV3D), four dimensional transvaginal sonography (TV4D), hysteroscopy and the magnetic resonance imaging (MRI) and computed tomography (CT).[1]

TV2D has some disadvantages, including the inability to identify a polyp from a fibroid and trouble detecting endometrial abnormalities such endometritis and synechiae. TVS cannot also be used to evaluate tubal patency.[2]

By using TVS, it is possible to perform a precise assessment of the uterine morphology, including the endometrial lining and the outer shape of the uterine muscle. With instillation of isotonic saline solution into uterine cavity through a catheter, the intrauterine pathologies, such as submucous myomas, endometrial polyps, and septate uteri, can be

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accurately diagnosed. The patency of bilateral tubes can be detected too. The procedure is called sonohysterography, which is particularly useful in infertile patients.[3]

TVS 4D is a novel imaging method. It has the capacity to simultaneously register all three image planes and view surfaces in three dimensions. The uterus can be observed in the coronal plane using TVS 4D, which is rarely possible with traditional scans. This makes it a special diagnostic tool for noninvasive uterine morphology studies and the identification of congenital uterine malformations.[4]

Due to its ability to assess the intramyometrial portion of the fibroid and calculate the 'extension index', a new method to classify submucous fibroids by four-dimensional SIS may enhance the preoperative selection of patients with submucous fibroids who are appropriate for hysteroscopic removal.[5]

Because it provides for direct visibility, hysteroscopy is regarded as the gold standard for uterine cavity examination. A small-diameter hysteroscope and saline distension can be used to do diagnostic hysteroscopy in the office, frequently without the requirement for anesthesia. Hysteroscopy is often scheduled during the early-to the mid-follicular phase of the cycle to maximize view of the endometrial cavity and prevent performing the operation during early pregnancy.[6]

Hysteroscopy is a simple, painless, and safe treatment. As a result, it has developed into a fantastic tool for the investigation and treatment of infertility. Hysteroscopy has frequently been recommended as a regular technique before IVF/ICSI.[7]

In order to assess aberrant uterine cavities in infertile women, this study compared the efficacy of TV4D US versus hysteroscopy.

2. Patients and methods

The current study was a prospective, comparative, observational study conducted between 2021 and 2023 that involved 100 infertile women who had uterine intracavitary lesions or abnormalities identified by hysterosalpingography and/or traditional vaginal ultrasound and who had attended the outpatient gynecologic clinic at Al-Azhar University Hospitals.

Infertile females with uterine intracavitary lesions or abnormalities identified by hysterosalpingography and/or traditional vaginal ultrasound were included in this investigation. After receiving written consent prior to the start of the study, the investigator interviewed each patient and completed the attached questionnaire.

Inclusion criteria: women of childbearing age, those who have been infertile for more than a year, those who have recently undergone a two-dimensional conventional ultrasound that revealed a lesion or abnormality in the uterine cavity, such as fibroids, polyps, or septations, or those who have recently undergone a hysterosalpingogram that revealed filling defects or abnormalities in the uterine contour.

Exclusion criteria: women who are or fear they are pregnant, those who have a hysteroscopy contraindication (such as severe vaginitis or cervicitis or a history of PID), and those who lack informed written consent.

Ethics: before recruiting participants for the study, informed consent was obtained from each participant after the study's purpose and methods were explained.

2.1. Methods

All patients were subjected to the following:

History taking: Each patient was subjected to full history taking which involve: personal history: name, age, marital status, residence, parity etc. Menstrual history: regular menses, normal pattern, symptoms suggestive of ovulation. Date of the last menstrual period. Past history of cesarean section, myomectomy, ovarian cystectomy, laparotomy operations, salpingectomy … etc. History suggestive of endometriosis (infertility, dyspareunia, dysmenorrhoea). Sexual history (frequency, positions, use of lubricants, dyspareunia, postcoital spill of semen, vaginismus … etc). Obstetric and contraceptive history in cases of secondary infertility, i.e. septic abortion, puerperal sepsis, severe obstetrical hemorrhage.

2-Examination: General examination: including vital signs (pulse, blood pressure and temperature) and examination of the head, neck, chest, heart and limbs. Abdominal examination: organomegaly, masses and ascites. Pelvic examination: inspection, palpation, bimanual examination and speculum examination.

Investigations: Routine Investigations: Complete blood picture, random blood sugar, liver and kidney function tests. Hormonal profile: Serum Follicle-stimulating hormone (FSH) and luteinizing hormone (LH) day three of the cycle, serum progesterone day 21 of the cycle, serum prolactin (PRL), thyroid stimulating hormone (TSH), and anti-mullerian hormone (AMH). Hysterosalpingography and two dimensional sonography (2D US) done within 3 months before the study, and showed abnormal uterine finding; regardless their age, complaint and parity.

Interventions: all patients were subjected to the following:

TV4D: utilizing an intravaginal 5 MHz TVS4D probe. The automated sweep of the mechanical transducer produces a four dimensional volume after obtaining a longitudinal picture of the uterus. The volumes will be digitally archived and subjected to multi-planar visualisation analysis.

Diagnostic hysteroscopy: using a rigid panoramic type device with a continuous irrigation and suction sheath, an outer sheath of 5.5 mm, and a 30° fore-oblique lens, all patients had diagnostic hysteroscopy (DHS) in the postmenstrual phase. The surgery was carried out while completely unconscious. Some patients received 400 gm misoprostol tablets (per-vaginum) 2 h before the cervical softening operation.

2.2. Statistical analysis

The information was gathered and entered into the computer.

The Statistical Package for Social Sciences (SPSS/ version 17) tool will be used for the statistical analysis. The subsequent statistical analysis was used: The results of 4D US and diagnostic hysteroscopy was compared with respect to their sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy (DA). It is acknowledged that diagnostic hysteroscopy (DHS) will serve as the standard by which other scanning methods will be measured.

3. Results

This prospective study was conducted on 100 females attended the outpatient gynecologic clinic at Al-Azhar University Hospitals. Women were enrolled in this study aiming to compare the accuracy of 4D US versus Hystroscopy in assessment of abnormal uterine cavity in infertile women (Table 1).

This table shows that patients' age ranged 20–35 years with mean BMI 25.41 kg/m^2. Majority of the patients were rural (Table 2).

Table 1. Demographic characteristics among studied patients.

	Patients (n = 100)
Age (y)	
Mean ± SD	30.71 ± 4.03
Range	20–35
BMI (kg/m^2)	25.41 ± 4.58
Mean ± SD	20–30
Range	
Residence	
Rural	60 (60%)
Urban	40 (40%)

This table shows that regarding US, the most prevalent finding was polyp (38%) followed by myoma (21%). Meanwhile, there was 17% of the patients were normal US. Regarding hysteroscopy, only 4 patients were normal while 42% were polyp and 23% were myoma (Table 3).

This table shows that US was significant with sensitivity of 87.5% and specificity of 100% while PPV was 100% and NPV was 25% with accuracy of 88% (Table 4).

This table shows that US was significant with sensitivity of 86.96% and specificity of 98.7% while PPV was 95.24% and NPV was 96.2% with accuracy of 96% for diagnosis myoma (Table 5).

This table shows that US was significant with sensitivity of 90.48% and specificity of 100% while

Table 2. Ultrasonography versus hysteroscopy findings among studied patients.

	US N (%)	Hysteroscopy N (%)
Normal	16 (16%)	4 (4%)
Myoma	21 (21%)	23 (23%)
Polyp	38 (38%)	42 (42%)
Adhesions	8 (8%)	10 (10%)
Septum	17 (17%)	21 (21%)

Table 3. Comparison between transvaginal Ultrasonography findings with hysteroscopy among the studied patients.

Transvaginal	Hysteroscopy		Total	P
	Abnormal	Normal		
Abnormal	84 (87.5%)	0	84 (84%)	**<0.001**
Normal	12 (12.5%)	4 (100%)	16 (16%)	
Total	96 (100%)	4 (100%)	100	
Statistic	Value	**95% CI**		
Sensitivity	87.5%	79.18%–93.37%		
Specificity	100%	39.76%–100%		
Positive Predictive Value	100%	–		
Negative Predictive Value	25%	16.41%–36.14%		
Accuracy	88%	79.98%–93.64%		

Table 4. Comparison between transvaginal ultrasonography with hysteroscopy among the studied patients in diagnosis of myoma.

Transvaginal	Hysteroscopy		Total	P
	Myoma	None		
Myoma	19 (82.6%)	2 (2.6%)	21 (21%)	**<0.001**
None	4 (17.4%)	75 (97.4%)	79 (79%)	
Total	23 (100%)	77 (100%)	100	
Statistic	Value	**95% CI**		
Sensitivity	86.96%	66.41%–97.22%		
Specificity	98.7%	92.98%–99.97%		
Positive Predictive Value	95.24%	73.93%–99.30%		
Negative Predictive Value	96.2%	89.81%–98.64%		
Accuracy	96%	90.07%–98.90%		

PPV was 100% and NPV was 93.55% with accuracy of 96% in diagnosis polyp (Table 6).

This table shows that US was significant with sensitivity of 70% and specificity of 98.89% while PPV was 87.5% and NPV was 96.74% with accuracy of 96% in diagnosis adhesions (Table 7).

This table shows that US was significant with sensitivity of 76.19% and specificity of 98.73% while PPV was 94.12% and NPV was 93.98% with accuracy of 94% in diagnosis septum.

Table 5. Comparison between transvaginal ultrasonography with hysteroscopy among the studied patients in diagnosis polyp.

Transvaginal	Hysteroscopy		Total	*P*
	Polyp	None		
Polyp	38 (90.5%)	0	38 (38%)	**<0.001**
None	4 (9.5%)	58 (100%)	62 (62%)	
Total	42 (100%)	58 (100%)	100	
Statistic	Value	**95% CI**		
Sensitivity	90.48%	77.38%–97.34%		
Specificity	100%	93.84%–100%		
Positive Predictive Value	100%	–		
Negative Predictive Value	93.55%	85.09%–97.36%		
Accuracy	96%	90.07%–98.9%		

Table 6. Comparison between transvaginal ultrasonography with hysteroscopy among the studied patients in diagnosis adhesions.

Transvaginal	Hysteroscopy		Total	*P*
	Adhesions	None		
Adhesions	7 (70%)	1 (1.1%)	8 (8%)	**<0.001**
None	3 (30%)	89 (98.9%)	92 (92%)	
Total	10 (100%)	90 (100%)	100	
Statistic	Value	**95% CI**		
Sensitivity	70%	34.75%–93.33%		
Specificity	98.89%	93.96%–99.97%		
Positive Predictive Value	87.5%	48.88%–98.09%		
Negative Predictive Value	96.74%	92.00%–98.71%		
Accuracy	96%	90.07%–98.90%		

Table 7. Comparison between transvaginal ultrasonography with hysteroscopy among the studied patients in diagnosis septum.

Transvaginal	Hysteroscopy		Total	*P*
	Septum	None		
Septum	16 (76.2%)	1 (1.3%)	17 (17%)	**<0.001**
None	5 (23.8%)	78 (98.7%)	83 (83%)	
Total	21 (100%)	79 (100%)	100	
Statistic	Value	**95% CI**		
Sensitivity	76.19%	52.83%–91.78%		
Specificity	98.73%	93.15%–99.97%		
Positive Predictive Value	94.12%	69.22%–99.13%		
Negative Predictive Value	93.98%	87.89%–97.10%		
Accuracy	94%	87.40%–97.77%		

4. Discussion

TVS is a noninvasive imaging method that can produce precise images of the uterus's exterior contour and endometrial cavity. The availability of four-dimensional sonographic technologies in therapeutic settings has increased. With this technique, a large amount of data must be collected, and images in the transverse, sagittal, and coronal planes must be quickly reconstructed.[8]

The patients were between the ages of 20 and 35, with a mean age of 30.7 and a mean BMI of 25.41 kg/m^2. Most of the patients were from rural areas. Study by Mohammad et al.,[9] which showed that observation of the age in study group revealed that the mean age was 34.59.57 years, confirmed our findings. The patients' average BMI was 29.47 4.24 kg/m^2. Similar to this, Mohamed et al.,[10] reported that their study involved 48 women, ages ranging from 26 to 65, with a mean age of 34.58 ± 10.08 SD. A couple is said to be infertile if they have not become pregnant for at least a year after having regular, unprotected sexual activity.

You can have primary or secondary infertility.

There are several reasons for infertility, however tubo-peritoneal pathology accounts for 30–40% of instances, while uterine disease only accounts for 15%. In addition, ovulatory dysfunction (20–40%) is a factor. Male component contributes to infertility in 20–40% of instances.[11]

The current investigation revealed that the average time of infertility was 2.69 years. Mean parity is 3.16 1.25 and mean gravidity is 3.96 1.64, respectively. The majority of the patients (68%) had the primary kind of infertility. Study by Wadhwa et al.,[12] which found that the majority of cases (73.14%) of primary infertility (79/108) and secondary infertility (26.75%) (29/108) were secondary infertility, confirmed the findings. In their investigation, women's ages ranged from 27.56 to 2.80. The majority of women were in the age range of 26–28 years, where they made up 39.8% (43/108), followed by the age ranges of 23–25 years (27.8%/31/108), and 29–31 years (23.1%/108). The average time of infertility was 5.65 2.54 years.

The study by Sahu et al. also included[13] hysteroscopies on 324 infertile women, 232 (71.60%) of whom had main infertility and 92 (28.40%) had secondary infertility. Thirty years old in the group with secondary infertility, the parity ranged from 1 to 2, the number of spontaneous abortions ranged from 0 to 7, and the number of induced abortions ranged from 0 to 2.

The assessment of women presenting with infertility traditionally includes measures of the

antimullerian hormone, prolactin, and thyroid stimulating hormone.[14]

The results of the current investigation revealed that the average levels of FSH were 12.53 4.89 mIU/ml, LH was 11.82 3.59 mIU/ml, and progesterone was 5.47 2.21 ng/ml and prolactin was 28.96 10.32 ng/ml. In the study by Sathiyanarayanan et al.,[15] patients (~60%) with high prolactin levels displayed lower FSH and LH levels than the healthy control group. Seth et al. found that 15 main infertile women had somewhat higher mean levels of LH than secondary infertile women. This distinction, nevertheless, was not statistically significant. Although secondary infertility had somewhat higher FSH levels than initial infertility, the statistical difference was negligible. However, women with primary infertility had a significantly greater LH/FSH ratio than women with secondary infertility (P 0.05). Serum TSH and prolactin levels did not significantly differ across the groups. To the best of our knowledge, this is a novel study that compares the precision of Hystroscopy with four-dimensional US in determining whether an infertile woman's uterus is abnormal. Myoma (21%), followed by polyp (38%) was the most frequent discovery in the study we have in front of us regarding the US. In the meantime, 16% of the patients were average US citizens. Only four patients had normal hysteroscopies, while 42% had polyps and 23% had myomas.

Our findings were corroborated by a research by Mohammad et al.[9] who noted the following distinctions between three-dimensional-TVUS and hysteroscopy's diagnostic capabilities:

Two of the ten endometrial polyps detected by hysteroscopy that were overlooked by three-dimensional US out of the ten cases.

They identified 7 cases of intrauterine adhesions, 7 of which had hysteroscopy confirmation and 3 of which had been overlooked by three-dimensional ultrasonography. In the study by Al-Zinaty et al.,[16] of the 52 investigated cases ($n = 52$) had lesions that could be seen either by hysteroscopy or by three-dimensional US. Of these, ($n = 24$) lesions could be seen by both hysteroscopy and ultrasound, whereas ($n = 20$) lesions could not be seen by either method. Ultrasonography detected ($N = 12$) lesions that hysteroscopy missed, while ($N = 10$) lesions were detected by hysteroscopy but not by ultrasound. In addition, a research by Sinha et al. found that[17] hysteroscopies were able to identify 53.6% of women who had abnormal uterine pathology, including polyps in 16.1% of cases, 10.7% of cases had submucous fibromas, 7.1% had necrotic masses, and 5.4% had adhesions. Uterine abnormalities that are either congenital, like Müllerian defects, or acquired (e.g. Submucous myomas, endometrial polyps, adhesions).

TVUS is an effective method for the early assessment of uterine diseases. The coronal view of the uterus, one of the most valuable scan planes acquired on four-dimensional US, is frequently not possible on two-dimensional US due to anatomical restrictions (the vaginal probe has limited mobility within the confines of the vagina). These coronal views demonstrate how the endometrium and myometrium interact at the uterine fundus while emphasising the cornual angles and the entire cervical canal.

It was shown that while dealing with complicated anatomy or a number of findings, the coronal plane was quite beneficial.[18]

During a hysteroscopy, the uterine cavity and cervical canal can be directly observed.

Hysteroscopy is used to accurately and conveniently diagnose intrauterine abnormalities. As a warning A thorough diagnosis is essential to target treatment at the specific pathology and avoid unnecessary surgery; outpatient clinics do the majority of hysteroscopy procedures. Hysteroscopy is a significant step in the infertility workup prior to ICSI, even in patients with normal TVUS.[19] According to the current study, US had a significant sensitivity and specificity of 86.96% and 98.7%, as well as a PPV and NPV of 95.24 and 96.2%, respectively, with an accuracy of 96% for myoma diagnosis. In the study by Mohammad et al., 14 (28%) individuals were found to have submucous myomas using three-dimensional-TVUS, and 14 (28%) more cases were identified as having them by hysteroscopy. For myomas (submucous myomas), the three-dimensional-TVUS sensitivity, specificity, PPV, NPV, and overall accuracy were all 100%. Additionally, Balen et al.[20] 's findings showed that hysteroscopy and three-dimensional-TVUS both had a 100% sensitivity and specificity for detecting polypoid structures in the uterine cavity, including endometrial polyps and submucous myomas. The current study shown that US was significant with sensitivity of 90.48% and specificity of 100%, while PPV and NPV were 100% and 93.55%, respectively, with an accuracy of 96% in polyp identification. Our findings were consistent with the findings of Mohammad et al. study's,[9] which stated that for the examination of uterine polyps, three-dimensional-TVUS found only 8 (16%) instances to have polyps before hysteroscopy revealed 10 (20%) cases to have polyps. The accuracy, PPV, NPV, sensitivity, and specificity of three-dimensional-TVUS were all 80, 100, 100, and 95.24%, respectively. Furthermore, Ebrashy et al. study's[21] found that four-dimensional USS is

far superior to hysteroscopy at pinpointing the precise location of submucous myomas or endometrial polyps in relation to the cavity.

Furthermore, it was found that hysteroscopy had 100% sensitivity and 100% specificity for diagnosing endometrial hyperplasia, submucous leiomyoma, and endometrial polyps, compared with 87.5% sensitivity and 98.1% specificity for endometrial carcinoma, proving how effective hysteroscopy is at detecting endometrial disease. Using hysteroscopy, it was possible to diagnose submucous fibroid with 100% specificity and 100% sensitivity, endometrial hyperplasia in postmenopausal hemorrhage with 100% specificity and 100% sensitivity, and endometrial cancer with 50% specificity and 100% sensitivity.

In the study we are working with, PPV and NPV had accuracy of adhesions diagnosis of 96.74% and 96%, respectively, while US had a significant sensitivity and specificity of 98.89%. Our findings were supported by a study by Mohammad et al.[9] who discovered that, for intrauterine adhesions evaluation, three dimensional-TVUS detected only 4 cases of intrauterine adhesions (8%), whereas hysteroscopy discovered 7 cases (14%) and 3 cases (6%), demonstrating how sensitive the hysteroscope is for making this diagnosis. The 3DTVUS's respective PPV, NPV, sensitivity, specificity, and accuracy were all 57.14, 100, 100, and 93.48%. Contrary to a study by Knopman and Copperman,[22] which asserted that intrauterine adhesions (IUAs) were always detectable with four-dimensional US and HSG and validated by hysteroscopy, these findings are inconsistent with that study. Our results showed that US was significant with sensitivity of 76.19% and specificity of 98.73% while PPV was 94.12% and NPV was 93.98% with accuracy of 94% in diagnosis septum. In accordance with our results, in a study which was done by Karasu and Metwally,[23] stated that four-dimensional USS has high sensitivity in the diagnosis of septate uterus but has a low sensitivity (52%) in the diagnosis of intrauterine adhesions.

According to Arefi et al.[24] stated that the hysteroscopy has a higher sensitivity and specifity compared with other diagnostic tools (saline infusion hysterosonography 'SIHS', TVS, and three-dimensional USS) and stated that hysteroscopy is the gold standard for the investigation of uterine cavity. It is a safe test for the direct and accurate diagnosis of intrauterine abnormalities.

In the study of Grigore et al.,[25] when it came to diagnosing anomalies in the uterine cavity, four-dimensional US showed a sensitivity of 88%, specificity of 94%, positive predictive value of 96%, negative predictive value of 84%, likelihood ratio of 5, 5, and accuracy of 90%. For polyps (97% and 97%, respectively), congenital uterine abnormalities (100% and 99%, respectively), and submucous myoma (87% and 100%, respectively), three-dimensional US exhibited good sensitivity and specificity; however, uterine synechia (41% and 99%, respectively) had a poor sensitivity.

4.1. Conclusion

Our research allowed us to draw the conclusion that four-dimensional TVS can be utilised to diagnose uterine focal lesions with outcomes that are on par with hysteroscopy. The greatest benefit of hysteroscopy is that it allows for surgical intervention in the same location, making it the gold standard diagnostic and therapeutic technique for uterine anomalies (bicornuate, septate, arcuate, and polyp).

Only a diagnostic tool, four-dimensional US is superior to hysteroscopy in several lesions, such as (subserous and intramural fibroid). Gives more benefit in more precise measurement of the size, consistency, and vascularity, which is not always visible in hysteroscopy. Intrauterine adhesions and endometrial polyps, however, are harder to diagnose.

Disclosure

The authors have no financial interest to declare in relation to the content of this article.

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Conflicts of interest

The authors declared that there were no conflicts of interest.

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