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Evaluation of subtle fallopian tube abnormalities in women with unexplained subfertility: a cross-sectional study

Ahmed Shoukry ^{1*}, Amr Mansy ¹, Marwan AbdElKader ², Tamer Hanafy Mahmoud ¹

¹ Department of Obstetrics and Gynecology, Faculty of Medicine, Alexandria University, Alexandria, Egypt.

² Shatby women University Hospital, Alexandria University Hospitals, Alexandria, Egypt.

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*Corresponding author: Ahmed Shoukry, M.D., PhD. Department of Obstetrics and Gynecology, Faculty of Medicine, University of Alexandria, Champollion Street, Azarita discrete, Alexandria, Egypt.
Email: ahmedshoukry1989@outlook.com.
ORCID: 0000-0002-3422-3822.

ABSTRACT

Objective. Non-obstructive lesions outside the fallopian tube are referred to as subtle distal fallopian tube abnormalities, such as tubal diverticula, Morgagni cyst, sacculization, accessory tube, accessory ostium, and fimbria agglutination. There is considerable evidence to suggest that these defects have a negative impact on fertility and may contribute to some cases of unexplained infertility. By implementing this adjustment for the treatment of tubal infertility, we can lower the incidence of “unexplained infertility”, which could lead to unnecessary IVF. to investigate the prevalence and types of subtle tubal abnormalities detected during laparoscopy in women with unexplained subfertility.

Patients and Methods. 120 women with unexplained infertility scheduled for diagnostic laparoscopy were included in the study. Evaluation of fallopian tubes is done by grasping the fimbria with non-traumatic forceps and thoroughly inspecting both sides for one or more of the abnormalities, followed by confirmation of tubal patency via chromopertubation.

Results. The prevalence of subtle tubal abnormalities diagnosed by laparoscopy was 58% (70/120). Positive laparoscopic findings were found bilaterally in 43 out of 70 (61.5%) women and unilaterally in 27 out of 70 (38.5%) women. Tubal sacculization was the most prevalent anomaly, at 47.14% (33 out of 70). Peritubal adhesions were significantly higher in women with subtle abnormalities; however, there was no statistical correlation between superficial endometriosis and the presence of these anomalies.

Conclusions. subtle tubal abnormalities have a high prevalence in women with unexplained infertility, and they may be linked to the aetiology of subfertility in this population.

INTRODUCTION

Subtle distal fallopian tube abnormalities, such as fimbrial agglutination, tubal diverticula, and Hydatid of Morgagni (HM), are a category of lesions charac-

terized by minor changes in tubal morphology [1]. For a long while, even though this group of tubal disorders was first mentioned in literature over a century ago, it was believed that they were only normal anatomic variations with no practical significance [2-4].

These anomalies involve fimbria agglutination, fimbria phimosis, Morgagni hydatids cyst, tubal sacculation, tubal diverticula, accessory ostium, and accessory fallopian tube [5].

It's important to comprehend subtle tubal abnormalities. These non-obstructive lesions are underdiagnosed despite their relatively high prevalence. As a result, they are typically missed during laparoscopy and dye tests, which exclusively evaluate tubal patency. Consequently, it is imperative to thoroughly examine the tube, especially the distal portion [1].

The clinical significance of fallopian tube anatomical and congenital abnormalities is frequently underestimated or disregarded [6]. There is fair evidence that these abnormalities may reduce fertility. The incidence of unexplained infertility could be lessened by implementing this modification for the treatment of tubal factor infertility, thus could prevent needless IVF procedures [5].

The aim of this study is to investigate the prevalence, types, and determinants of subtle tubal abnormalities detected during laparoscopy in women with unexplained subfertility.

PATIENTS AND METHODS

This observational cross-section study was conducted in the period from 1st May 2023 to 31st May 2024, on 120 infertile women who were originally diagnosed as having unexplained infertility and scheduled for diagnostic laparoscopy at the endoscopy unit at El-Shatby University Hospital, Alexandria, Egypt. We obtained the ethical approval for the study protocol from the local Ethical Committee of the Faculty of Medicine, Alexandria University (IRB No. 00012098). An informed written consent was provided for every female included in the study.

The sample size was calculated using Power Analysis and Sample Size Software (PASS 2020) "NCSS", taking into consideration a 5% level of significance, and precision of 5% using Z- test.

The study population includes women with primary or secondary infertility scheduled for laparoscopy and aged 20-37 years with any gravidity and parity, having regular menstrual cycles. Both fallopian tubes should be patent by means of hysterosalpingogram (HSG) and normal parameters of male partner's semen analysis.

Exclusion Criteria: Women with BMI ≥ 35 kg/m², women with ovarian pathology diagnosed by ultrasound, with low ovarian reserve, and women with congenital uterine anomalies were excluded from the study.

Surgical procedure: laparoscopy was performed during the post-menstrual phase of the cycle by surgeons who are oriented with the types and variations of subtle tubal abnormalities, all cases were recorded and revised by senior surgeons to double check the diagnosis.

Upon laparoscopy, the patient lies in the lithotomy position, per-vaginal examination was done, the anterior lip of the cervix is held by a vulsellum, and a manipulator is inserted in the cervical canal. Creation of pneumoperitoneum. Use the umbilicus for the camera port. Introduce the accessory and suprapubic trocars. Laparoscopic evaluation of the ovaries, the appearance of the tubes, fimbria-ovarian relationship, and any pelvic adhesions.

Evaluation of fallopian tubes was done by grasping the fimbria with non-traumatic forceps and thoroughly inspecting both sides for one or more of the following subtle abnormalities:

- Tubal sacculation (**Figure 1**) is a herniation of the tubal ampulla arising from deficient or absent the layer of tubal musculosa.

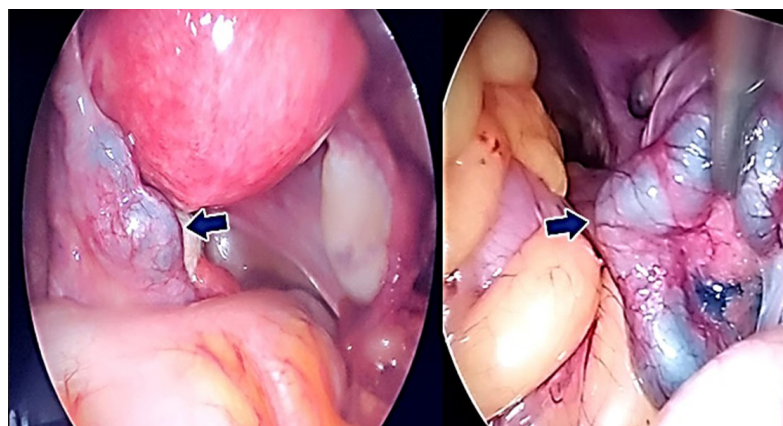


Figure 1. Tubal sacculation.

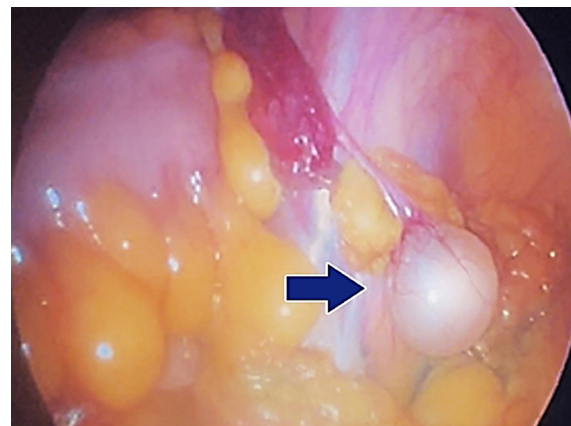


Figure 2. Hydatid (Morgagni) of Fallopian tube.

- Morgagni cysts or hydatids (**Figure 2**) are pedunculated cystic lesions attached to the fallopian tubes usually in proximity to the fimbria.
- Fimbria phimosis (**Figure 3**) is a concentric stricture located at the infundibular fimbrial junction of the fallopian tube.

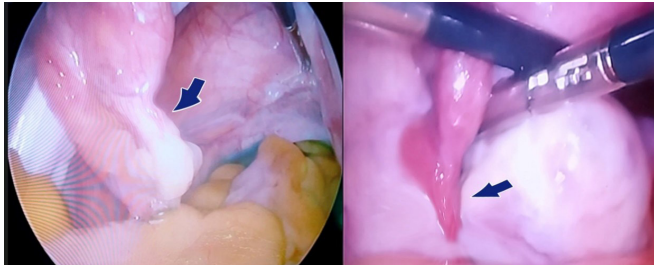


Figure 3. Fimbria phimosis.

- Tubal diverticula (**Figure 4**) are defined as a thin-walled, outpouching, clear cyst in the ampullary or fimbrial portion of the fallopian tube.

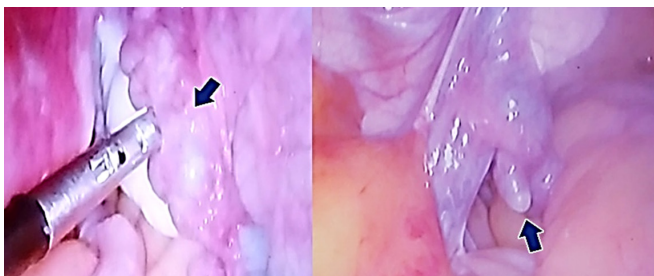


Figure 4. Tubal diverticulum.

- Accessory Fallopian tube (**Figure 5**) is an anomalous structure that is attached to the ampullary part of the main tube; the fimbrial end is open and has fine fimbriae lined with normal epithelium, like the main tube but with no communication between the lumen of the main tube.

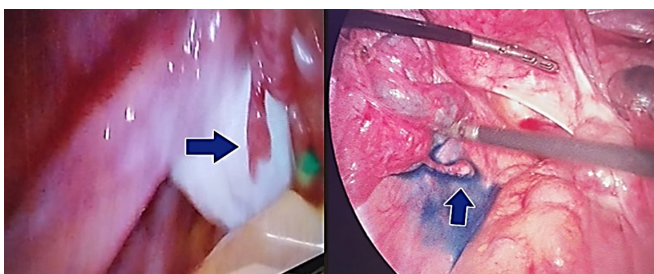


Figure 5. Accessory Fallopian tube.

- Fimbria agglutination (**Figure 6**) is defined as one or more adhesive bridges of fimbria across the ostium.

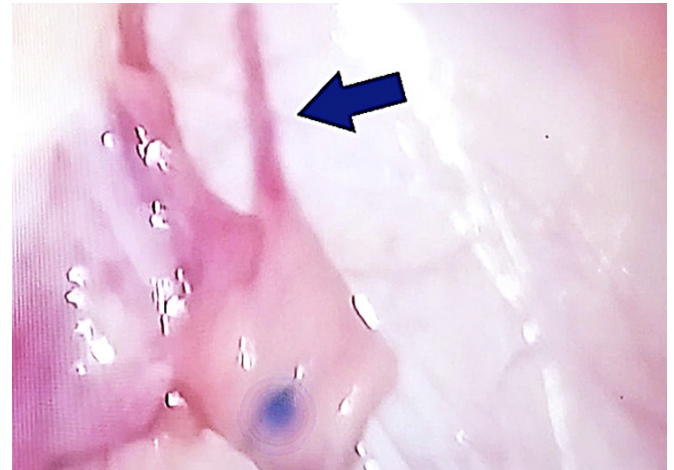


Figure 6. Tubal agglutination.

Accessory ostium is defined as an ectopic fimbria located a distance from the fimbriated end.

Confirmation of tubal patency by injecting methylene blue test through the cervix and observing the spillage of the dye into the peritoneal cavity.

Statistical analysis of the data

Data was fed to the computer and analysed using IBM SPSS software package version 20.0. (Armonk, NY: IBM Corp). Qualitative data were described using numbers and percentages. The Shapiro-Wilk test was used to verify the normality of distribution quantitative data described using range (minimum and maximum), mean, standard deviation, median, and interquartile range (IQR). The significance of the obtained results was judged at the 5% level.

The used tests were:

1. Chi-square test for categorical variables, to compare different groups.
2. Fisher or Monte Carlo correction for correction of chi-square when more than 20% of the cells have an expected count of less than 5.
3. Student t-test for normally distributed quantitative variables, to compare between two studied groups.
4. Mann Whitney test for abnormally distributed quantitative variables, to compare between two studied groups.

RESULTS

From the 154 women screened for enrolment in the study, the current study included 120 eligible women with unexplained infertility. **Table 1** demonstrates the baseline demographic data and obstetric history of the study cohort.

Table 1. Demographic data and obstetric history of the study cohort

Parameter	Patients (n = 120)
Age (years)	
Mean ± SD	28.78 ± 4.95
Median (IQR)	29.0 (27.50 – 34.0)
BMI (kg/m ²)	
Mean ± SD	28.03 ± 2.69
Median BMI (IQR)	28.40 (26.5 – 29.4)
Infertility duration (years)	
Mean ± SD	4.44 ± 3.10
Median (IQR)	3.0 (2.75 – 6.50)
Type of infertility	
Primary	61 (50.8%)
Secondary	59 (49.2%)
Gravidity	
Nulligravida	60 (50%)
Gravida 1	31 (25.8%)
Gravida ≥ 2	29 (24.2%)
Parity	
Nulliparous	77 (64.1%)
Para 1	29 (24.2%)
Para ≥ 2	14 (11.7%)
Previous caesarean sections	
No	81 (67.5%)
1	29 (24.2%)
≥ 2	10 (8.3%)

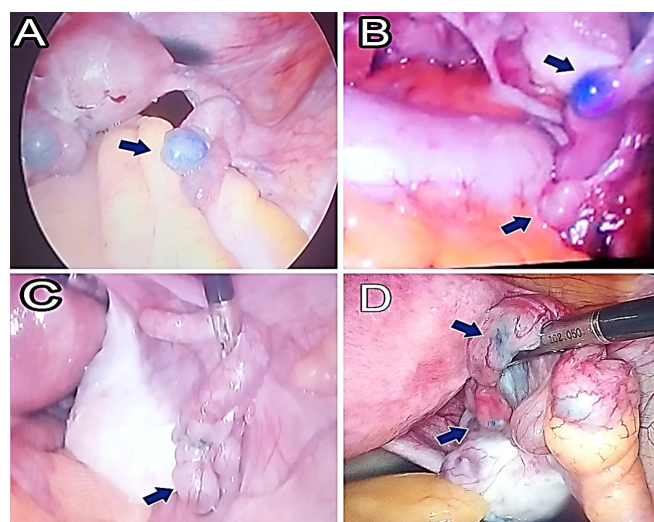


Figure 8. Combined Subtle Fallopian Tube Anomalies on the same tube.

(A) Sacculation & Phimosis; (B) Sacculation & Morgagni cyst; (C) Phimosis & Morgagni cyst; (D) Sacculation & accessory fimbrial ostium.

Regarding the prevalence of subtle fallopian tube abnormalities, 70 women (58.3% of the study population) had positive laparoscopic findings of 106 subtle fallopian tube abnormalities (per fallopian tube); 96 abnormalities as a single finding per

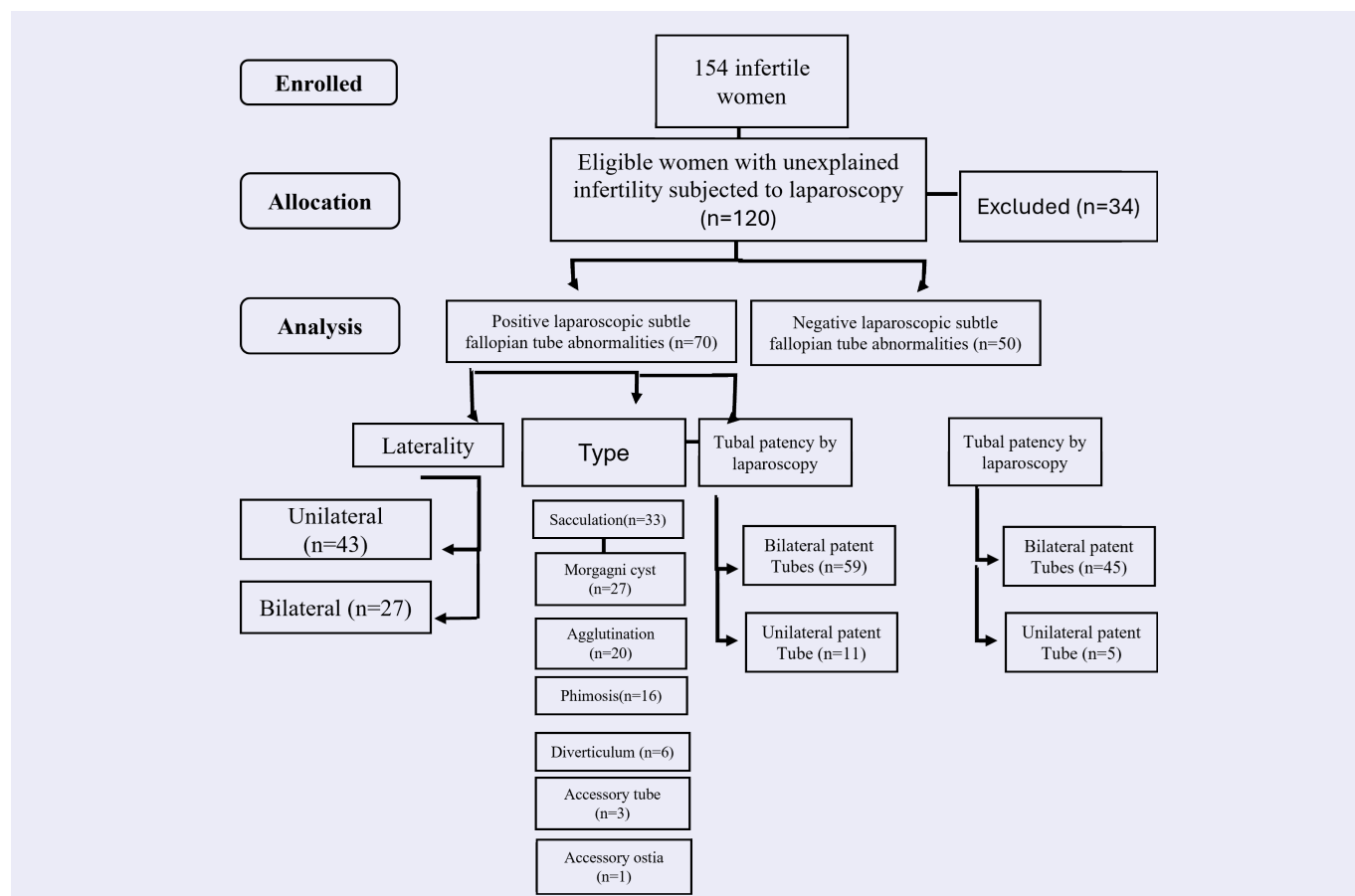


Figure 7. Study flow chart.

Table 2. The prevalence of different types of subtle tubal anomalies in the affected population.

Subtle tubal abnormality	n of anomalies out of the total 96 anomalies in the affected population
Tubal sacculation	29 (30.2%)
Unilateral finding	17 (17.7%)
Bilateral finding	12 (12.5%)
Morgagni cyst	25 (26%)
Unilateral finding	21 (21.9%)
Bilateral finding	4 (4.1%)
Tubal agglutination	20 (21%)
Unilateral finding	18 (18.9%)
Bilateral finding	2 (2.1%)
Tubal phimosis	13 (13.5%)
Unilateral finding	11 (11.4%)
Bilateral finding	2 (2.1%)
Tubal diverticulum	6 (6.3%)
Unilateral finding	5 (5.2%)
Bilateral finding	1 (1.1%)
Accessory fallopian tube	3 (3%)
Unilateral finding	3 (3%)
Bilateral finding	0 (0.0%)

Results expressed per fallopian tube.

tube and 10 abnormalities as a double lesion in the same fallopian tube, the study flowchart is illustrated in **Figure 7**. We had five cases with double lesion in the same fallopian tube, these lesions are demonstrated in **Figure 8**: two cases of sacculation and phimosis, one case of sacculation and Morgagni cyst, one case of sacculation and accessory ostia, one case of phimosis and Morgagni cyst.

These abnormalities were found in one fallopian tube (unilateral lesions) in 27 women (22.5%) and fallopian tubes were affected bilaterally with the same subtle anomaly in 43 (35.8%) of the affected women. Twenty-six women were found to have one subtle anomaly on one fallopian tube and another different type of anomalies on the other side. Other 5 women have combined anomalies on the same fallopian tube (**Figure 1**).

The frequencies of different types of subtle fallopian tube anomalies are tabulated in **Table 2**, the most common subtle anomaly was tubal sacculation with a frequency of 30.2% of the total subtle anomalies (29/96), followed by Morgagni cyst which represents 26% of the total anomalies.

Table 3. Comparison between the group with subtle tubal abnormalities and without abnormalities.

	Subtle fallopian tube abnormalities				Test of sig.	P-value
	Negative (n = 50)		Positive (n = 70)			
	No.	%	No.	%		
Mean age ± SD (years)	28.48 ± 5.50		29.0 ± 4.56		t = 0.565	0.573
Mean BMI ± SD (kg/m2)	28.29 ± 3.01		27.84 ± 2.43		t = 0.918	0.360
Duration of infertility					U = 1702.0	0.797
Median (Min-Max)	3.75 (1.0 – 12)	3.0 (1.0 – 20.0)				
Type of infertility					X²=0.024	0.877
Primary	25	50%	36	51.4%		
Secondary	25	50%	34	48.6%		
Mode of delivery					X²=2.585	MCp = 0.308
Nullipara	29	58%	48	68.6%		
Vaginal delivery	3	6%	1	1.4%		
Caesarean section	18	36%	21	30%		
Tubal patency by laparoscopy					X²=0.824	0.364
Bilateral	45	90%	59	84.3%		
Unilateral	5	10%	11	15.7%		
Peri-tubal adhesions					X²=5.878*	0.015
Absent	41	82%	43	61.4%		
Present	9	18%	27	38.6%		
Endometriosis					X²=0.311	0.576
Absent	42	84%	56	80%		
Present	8	16%	14	20%		

t: Student t test; X²: Chi-Square test; U: Mann-Whitney test; MC: Montecarlo correction; bold: statistically significant; *per patient; Results expressed per patient.

As aforementioned, we had five cases with double lesion in the same fallopian tube, these lesions are demonstrated in **Figure 8**.

Out of the 120 study subjects who have normal preoperative HSG, bilateral tubal patency was confirmed by means of laparoscopy in 86.7%, while 13.3% had only one patent fallopian tube on laparoscopic chromopertubation. Peri-tubal adhesions were observed in 36 women (30%) of the study cohort. There was no statistical association between presence of peri-tubal adhesions and tubal patency by laparoscopy ($p = 0.774$).

Table 3 shows comparison between the group of women with subtle tubal abnormalities (70 women) and women with no abnormalities (50 women), it reveals no statistically significant difference between the two groups as regards, age, BMI, type of infertility, duration of infertility, history of previous caesarean section, and tubal patency by laparoscopy.

There was a statistically significant difference between the two groups regarding the frequency and percentage of peri-tubal adhesions, they were higher for women with positive subtle fallopian anomalies (38.6%) than for women with no subtle fallopian anomalies (18%), $p = 0.015$.

Also, there was no statistically significant difference between the two groups regarding the presence or absence of endometriosis.

DISCUSSION

Laparoscopy is the gold standard diagnostic modality for assessment of tubal factor infertility. This is achieved by direct inspection of the fallopian tube and checking tubal patency and identifying any abnormalities. It can detect previously undiagnosed tubal disorders in women with normal HSG [7]. Diagnosis of subtle tubal abnormalities by HSG might be unreliable [8]. So, laparoscopy and thoroughly inspecting both sides of the fallopian tube are the main method applied for diagnosis.

Clinicians usually focus on diagnosing and treating hydrosalpinx and proximal tubal occlusion. Subtle distal tubal abnormalities that are non-obstructive lesions have received little attention [9].

The main findings of the current study are that the prevalence of subtle fallopian tube abnormalities in women with unexplained infertility, whether primary or secondary, is relatively high at 58%; and

these anomalies were bilateral in 61.5% and unilateral in 38.5% of the affected women.

A similar prevalence was reported by Guan *et al.* [1], who estimated the prevalence of subtle tubal abnormalities by laparoscopy to be present in 103 of 208 (54.3%) patients with infertility such as tubal diverticulum, Morgagni cysts, accessory fallopian tubes, tubal phimosis, agglutination, and sacculatation. While in contrast to our study, Zheng *et al.* [9], reported that among 876 cases, 28.7% were diagnosed with subtle fallopian tube abnormalities, this marked difference in prevalence might result from the large sample size of studied cases compared to this study and selection of all infertile females who underwent laparoscopy, not only infertile females with unexplained infertility.

The current study shows that sacculatation is the most common subtle anomaly, contributing for about one third of all diagnosed subtle anomalies. In alignment with this, Guan *et al.* [1], found that 24.5 % of unexplained infertile patients subjected to laparoscopy have had tubal sacculatation. According to our findings, Morgagni or Hydatid cyst was the second common reported anomaly with a prevalence of 26% of all anomalies, in a similar study of Cebeoy *et al.* [10], Morgagni cysts were reported to be present in 17.6% of the women with unexplained infertility, while in another larger study of Rasheed *et al.* [11], they have a much higher prevalence rate of 52.1% in women with unexplained subfertility. In this study, we reported that accessory fallopian tube is a rare finding with a prevalence of 3% of all anomalies. In agreement with this, Duraisamy *et al.* [12] described accessory fallopian tubes as a rare finding, the prevalence of this anomaly varies from 1.9% to almost 6% in infertile women. Nevertheless, Yablonski *et al.* [3], described a higher prevalence rate of accessory tubes in infertile women, 13 of 100 (13%) infertile women, this difference between this study and Yablonski *et al.* study regarding the prevalence of accessory tubes during laparoscopy is due to the selection of all infertile women not only unexplained infertile women.

Accessory tubal fimbrial ostium was reported in only one case of our cases, being the rearrest subtle tubal anomaly, a similar finding was also observed by Zheng *et al.* [4], who found the prevalence of accessory tubal ostium in women who underwent laparoscopy for unexplained infertility was 2 of 710 (0.3%). The aetiology of subtle tubal abnormalities has been a matter of debate whether they are congenital malformations with embryological or develop-

mental origin or, they are acquired lesions resulting from previous pelvic surgeries, pelvic or peri-tubal adhesions, or endometriosis. In this study, it was observed that the percentage of previous caesarean sections and endometriosis were not significantly higher in the presence of subtle tubal abnormalities, however peri-tubal adhesions were significantly higher in women with subtle abnormalities.

In concordance with our findings, there is fair evidence supporting that subtle tubal abnormalities have an embryological origin. Gardner *et al.* [13] stated that subtle tubal variations have been considered as congenital in nature. Cohen *et al.* [2] stated the accessory fallopian tubes are developmental anomalies by abnormal paramesonephric Müllerian duct development. Roland *et al.* [14] also reported that tubal diverticulum is a congenital condition. Csöbönyeiová *et al.* [6] also described that accessory tubal ostium is caused by the bifurcation of the distal end of the Müllerian ducts. In concordance, Lelchuk *et al.* [15] concluded that Morgagni cysts are remnants of paramesonephric Müllerian duct or mesonephric Wolffian duct found as a pedunculated or sessile cysts.

The relation between subtle tubal abnormalities and endometriosis has been addressed in the study of Abuzeid *et al.* [16], who found a close linkage between subtle distal abnormalities and endometriosis, especially early-stage endometriosis. And more recently in the study of Zheng *et al.* [5], that described a higher prevalence of pelvic endometriosis in infertile females diagnosed with subtle fallopian tube anomalies, they found that out of 251 cases with subtle anomalies, 178 (70.91%) cases were diagnosed to have pelvic endometriosis. They also observed that the prevalence of subtle distal abnormalities was significantly higher in the group of stage I-II endometriosis than in the group of stage III-IV (57.3% *vs* 20.9%, $p < 0.001$).

The limitations of this study include, a relatively small sample size, no control group to compare the prevalence of these abnormalities in fertile *versus* infertile women; also, we did not evaluate the effect of treatment of these tubal abnormalities in terms of reproductive outcomes.

CONCLUSIONS

Prevalence of subtle fallopian tube abnormalities diagnosed by laparoscopy in women with unexplained infertility is relatively high, tubal

sacculation and Hydatid or Morgagni cysts are the most common tubal subtle anomalies. Further studies are required with long term follow up to evaluate the effect of treatment of these abnormalities on the reproductive outcomes.

COMPLIANCE WITH ETHICAL STANDARDS

Authors' contribution

A.S.: Investigation, methodology, formal analysis, writing – original draft. T.H.M.: Conceptualization, supervision, writing – review & editing, validation. M.A.K.: Data curation, investigation, methodology. A.M.: Supervision, writing – review & editing.

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None.

Study registration

N/A.

Disclosure of interests

The authors declare that they have no conflict of interests.

Ethical approval

The study protocol was approved by the ethics committee of the Faculty of Medicine (IRB No. 00012098), Alexandria University, Egypt. Approval No. 0107681.

Informed consent

All study participants were told about the nature of the study and its aims, with comprehensive explanation of the procedures it entails, its expected risks and complications, then a written informed consent was obtained from every patient.

Data sharing

Data are available under reasonable request to the corresponding author.

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