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Comparative Anatomical Study of Fimbrial End of Fallopian Tubes in Ectopic Pregnancy

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ABSTRACT

Background: Ectopic pregnancy is also a leading death-cause of maternal morbidity with the most prevalent manifestation being tubal implantation. Although the destruction of the fallopian tube has been a focus, scant consideration has been given to the anatomy and microscopic alterations at the fimbrial end which is vital in the ovum capture and transport.

Methodology: The study was carried out as a comparative anatomy study in Pak International Medical College, Peshawar, in the period of one year, i.e. January 2024 to January 2025. Seventy-two fallopian tubes were studied that comprised of tubes of surgically treated ectopic pregnancies and a control group of non-pathological gynecology surgeries. The gross anatomical evaluation of fimbrial end was done and histopathological examination was also done using hematoxylin and eosin. The demographic and clinical information was taken and results were tallied using statistical analysis to compare the two groups.

Results: Cases of ectopic pregnancy showed extensive structural changes at the fimbrial end characterized by shortening of the fimbrial length, fewer fimbrial projections, and commonly congestion, edema, and adhesions. Microscopic observation showed that epithelial disruption, cilia loss, stromal edema and inflammatory cell infiltration occurred in a high percentage of ectopic samples and was not common in control samples. The difference that was observed was statistically significant.

Conclusion: The results of this research show that ectopic pregnancy is associated with the significant anatomical and histological destruction of fimbrial end of the fallopian tube. The possible problems with such changes are that they can disrupt normal ovum transport and cause abnormal tubal implantation. It is possible therefore that preservation of tubal health especially at the fimbrial end is significant in the mitigation of the risk of ectopic pregnancy...

Keywords: Ectopic pregnancy; Fallopian tube; Fimbrial end; Tubal anatomy; Histopathology..

1. INTRODUCTION

Ectopic pregnancy is a widespread gynecological emergency that has remained a serious risk to maternal health especially in low- and middle-income environments. Most of the cases of ectopic pregnancy take place in the fallopian tube and this underlines the significance of the structure and functions of the tubes in normal reproductive physiology. Although there has been advances in the methods of diagnosis and treatment, structural causes, which predispose to ectopic implantation, have not been fully established [1-3].

The fimbrial end of the fallopian tube is critical in achieving reproductive success since it captures the ovulated oocyte and helps it to pass through the tubal lumen. The coordinated movement of fimbria, intact epithelial lining and active cilia is important in this process. The presence of any interruption in the following parts can affect the transport of the ovum negatively and lead to the possibility of tubal implantation [4-6]..

Past studies have concentrated greatly on the risk factors including pelvic inflammatory disease, previous tubal surgery, and assisted reproductive techniques. Although these factors have been identified to result in the damage of the tube, there is lack of research on the gross and microscopic changes that take place at the fimbrial end during ectopic pregnancy. The knowledge of such changes can offer an idea of the pathophysiology of ectopic implantation and could assist in defining hidden manifestations of tubal malfunction [7-9].

The aim of the present study was to compare the anatomical and histopathological characteristics of the fimbrial end of fallopian tube in ectopic pregnancy with controls (normal tubes). This research will be used to help understand the role of fimbrial pathology in the formation of ectopic pregnancy by comparing structural changes with clinical evidences

2. METHODOLOGY

This was a comparative anatomy study done in the Department of Anatomy in coordination with the Department of Obstetrics and Gynecology in Pak International Medical College, Peshawar. The research time frame was from January 2024- January 2025. The study was conducted with ethical approval at the institution review committee before the study commenced. All actions were conducted according to the institutional and ethical standards and patient information confidentiality was strictly followed during the research process.

The study had seventy-two fallopian tube specimens as a total sample. These groups were equally separated into two. The participants of the study were fallopian tubes of patients who had undergone surgical management of ectopic pregnancy and the controls included fallopian tubes of women undergoing hysterectomy or salpingectomy due to non-tubal benign gynecological conditions without clinical or histological evidence of tubal pathology or disease. Cases with gross trauma, structural anomaly or malignancy were eliminated to eliminate factors that may confound structural changes.

Hospital records on relevant demographic and clinical data such as age, parity, obstetric history and relevant gynecological conditions were obtained at the point of specimen collection. All the fallopian tubes were identified to keep the right group of preserving the correct group assignment. Special care was taken to maintain the fimbrial end in surgical removal to provide proper anatomical measurements.

To examine the gross anatomy, the fimbrial end of each of the fallopian tubes was exceptionally examined following their fixation in 10% buffered formalin. The length of fimbriae was measured with the help of a calibrated measuring scale, and the number of fimbriae counted with the help of the naked eye. Congestion, edema, adhesions, surface irregularities, or distortion were recorded in a systematic manner. The observations were done independently to reduce observer bias.

After gross examination, histopathological evaluation was done by taking representative sections of the fimbrial end. The tissue samples were dehydrated in a series of alcohols, cleared in xylene, and paraffin wax. Slices of 45micrometers or so were cut with a microtome and stained with hematoxylin and eosin. Microscopic examination based on the integrity of the epithelia, preservation of the cilium, stromal edema, the presence of inflammatory cells, vascular congestion, and any sign of fibrosis or fibrinogenic alterations.

Microscopic assessments were performed under light microscopy by experienced observers who were blinded to the study groups. Findings were categorized using predefined criteria to maintain consistency. Any discrepancies in interpretation were resolved through joint review and consensus.

The data collected were entered and analyzed using standard statistical software. Continuous variables were indicated in the form of mean and standard deviation and categorical variables indicated in the form of frequencies and percentages. In comparison of the continuous variables, independent t-tests were used and chi-square tests were used in categorical data. The p-value that was deemed to be significant was 0.05 or below.

3. RESULTS

The demographic profile of participants was not substantially different in both study groups. Mean age and body mass index were similar, indicating well-matched cases and controls. The parity distribution did also not differ significantly, indicating minimal demographic confounding in subsequent analyses.

Table 1. Demographic characteristics of study participants (n = 72)

Variable	Ectopic Pregnancy (n = 36)	Control (n = 36)	p-value
Age (years), mean ± SD	29.8 ± 4.6	28.9 ± 4.2	0.412
Age ≤30 years, n (%)	21 (58.3)	24 (66.7)	0.468
Age >30 years, n (%)	15 (41.7)	12 (33.3)	
BMI (kg/m²), mean ± SD	26.1 ± 3.2	25.4 ± 3.0	0.336

Nulliparous, n (%)	18 (50.0)	14 (38.9)	0.344
Multiparous, n (%)	18 (50.0)	22 (61.1)	

Women with ectopic pregnancy had a higher frequency of previous reproductive and pelvic pathology. Ectopic group suffered more from histories of infertility, pelvic inflammatory disease and previous ectopic pregnancy. These findings suggest that damage in the tubes was already present.

Table 2. Gynecological and obstetric history of participants

Variable	Ectopic Pregnancy n (%)	Control n (%)	p-value
History of infertility	14 (38.9)	6 (16.7)	0.031*
Previous ectopic pregnancy	6 (16.7)	1 (2.8)	0.047*
Pelvic inflammatory disease	12 (33.3)	5 (13.9)	0.048*
Previous pelvic surgery	10 (27.8)	4 (11.1)	0.081
IUCD use	7 (19.4)	3 (8.3)	0.182

*Statistically significant ($p \leq 0.05$)

A physical examination found clear anatomical differences in ectopic versus control specimens. In cases of ectopic pregnancy, the fimbrial segment was much shorter with less fimbriae. Congestion, edema, and adhesions were significantly more common, suggesting structural distortion of fimbrial end.

Table 3. Gross anatomical findings of the fimbrial end

Variable	Ectopic Pregnancy (n = 36)	Control (n = 36)	p-value
Fimbrial length (cm), mean ± SD	1.9 ± 0.4	2.3 ± 0.5	0.002*
Number of fimbriae, mean ± SD	6.1 ± 1.2	7.4 ± 1.3	<0.001*
Fimbrial congestion, n (%)	26 (72.2)	8 (22.2)	<0.001*
Fimbrial edema, n (%)	24 (66.7)	6 (16.7)	<0.001*
Fimbrial adhesions, n (%)	18 (50.0)	4 (11.1)	0.001*

*Statistically significant ($p \leq 0.05$)

Microscopic analysis showed significant pathological changes in ectopic pregnancy. Ectopic group showed significantly more frequent loss of epithelial integrity and ciliary damage. Research found evidence of chronic fimbrial injury to the ovary.

Table 4. Histopathological features of the fimbrial end

Variable	Ectopic Pregnancy n (%)	Control n (%)	p-value
Epithelial disruption	22 (61.1)	6 (16.7)	<0.001*
Ciliary loss	25 (69.4)	7 (19.4)	<0.001*
Stromal edema	21 (58.3)	5 (13.9)	<0.001*
Inflammatory infiltration	23 (63.9)	6 (16.7)	<0.001*
Vascular congestion	20 (55.6)	7 (19.4)	0.002*

*Statistically significant ($p \leq 0.05$)

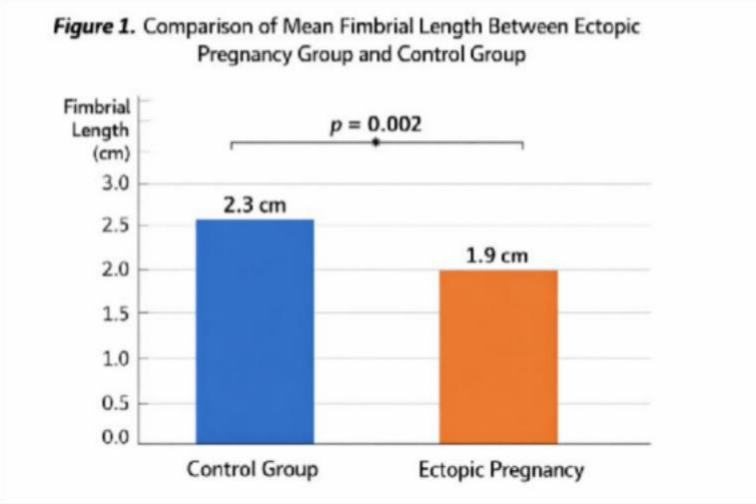

Figure 1: illustrates the comparison of mean fimbrial length between the ectopic pregnancy group and the control group. Specimens obtained from ectopic pregnancy cases demonstrated a noticeably shorter fimbrial segment compared with those from normal fallopian tubes. The difference observed between the two groups was statistically significant, indicating structural alteration of the fimbrial end in ectopic pregnancy.

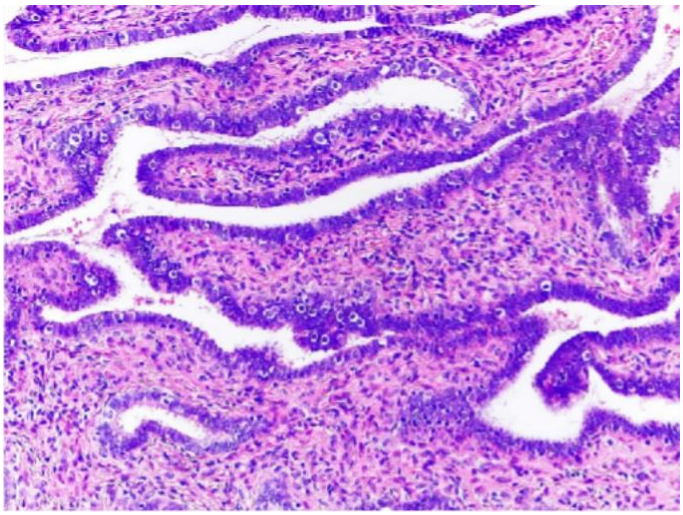

Figure 2*: Histopathological section of the fimbrial end of the fallopian tube (H&E stain), showing epithelial disruption, ciliary loss, stromal edema, and inflammatory cell infiltration in ectopic pregnancy.*

4. DISCUSSION

The current research indicates that at the fimbrial end of the fallopian tube, there are evident anatomical and microscopic variations in the presence of ectopic pregnancy compared to healthy tubes. Reduced length of the fimbrial segment in ectopic pregnancy samples was observed to have less fimbriae and often signs of congestion, edema and adhesions. Such gross alterations would imply that the fimbrial end, which is normally important in ovum capture and transportation, could be structurally defective in women who develop ectopic pregnancy [10-12].

Past researches have stressed the significance of preservation of fimbrial architecture in order to achieve successful gametal transportation and our results concur with this idea. A decrease in fimbrial length and degradation of normal fimbrial projections can potentially lead to poor sweep motion to move the ovum towards the tubal lumen. The frequency of congestion and adhesions noted in the ectopic group is also high, which is further supportive of the addition of chronic inflammatory processes in changing the normal fimbial anatomy [13-15].

The histopathological analysis of the study showed a significant epithelial damage, loss of cilia, stromal oedema and inflammatory infiltration in the fimbrial end of ectopic pregnancy specimens. The research results can be compared to the previous publications which reported tubal inflammation and ciliary damage to be the key players in ectopic pregnancy pathogenesis. As cilia are needed in the transport of the ovum, the absence or destruction of cilia may cause a delay of the transit of the fertilized ovum, which will enhance the probability of tubal implantation [16-18].

The correlation of ectopic pregnancy and the history of the pelvic inflammatory disease, infertility, and the history of the ectopic pregnancy observed in this research supports the association of the chronic tubal injury and the change of fimbrial structure further. The fimbrial end can become less functional due to inflammation related fibrosis and vascular congestion that may be progressive and distort the end of the fimbria. Although it may not be obvious scarring, it can be subtle microscopic damage that is enough to cause abnormal tubal physiology [19, 20].

The total of the gross and microscopic variations in this paper indicates that fimbrial end is not just a passive structure but rather an active agent in the progression of ectopic pregnancy when its integrity is disrupted. These results support the significance of timely intervention and treatment of pelvic infections and tubal pathology to maintain the functionality of the fimbriae, and lower the chances of the ectopic implantation.

5. CONCLUSION

This study demonstrates that ectopic pregnancy is associated with significant gross and microscopic alterations at the fimbrial end of the fallopian tube. Shortened fimbrial length, reduced number of fimbriae, epithelial disruption, ciliary loss, and inflammatory changes were notably more frequent in ectopic pregnancy specimens. These findings support the view that structural and functional impairment of the fimbrial end plays a crucial role in the pathogenesis of ectopic pregnancy.

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