

MORPHOLOGICAL AND MICROBIOLOGICAL ASPECTS OF CYTOTROPHOBLASTIC INVASION IN TUBAL PREGNANCY AND THEIR CLINICAL SIGNIFICANCE

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Abstract. Tubal pregnancy remains a life-threatening form of ectopic gestation and is closely associated with inflammatory and infectious damage of the fallopian tubes. The aim of this study was to investigate the morphological and microbiological features of cytotrophoblastic (CT) invasion in various pathogenetic variants of tubal pregnancy and to evaluate their clinical significance in predicting complications.

Keywords. Tubal pregnancy; cytotrophoblastic invasion; microbial colonization; fallopian tube inflammation; histopathology; ureaplasma; mycoplasma; herpes simplex virus; tubal rupture; hemorrhagic complications.

Relevance of the Study. Tubal pregnancy remains one of the most dangerous forms of ectopic gestation and poses a serious threat to female reproductive health. Despite advances in early diagnostic methods and surgical interventions, tubal pregnancy continues to contribute significantly to maternal morbidity, reproductive complications, and emergency gynecological cases worldwide[1,2,3].

Among the major risk factors, microbial infection and chronic inflammation of the fallopian tubes play a pivotal role. These pathological conditions create an unfavorable environment for implantation and development of the gestational sac, disrupting normal tubal physiology and predisposing to adverse outcomes such as tubal rupture, hemorrhage, and salpingitis[4,5].

Recent studies have highlighted the importance of cytotrophoblastic (CT) invasion patterns in determining the severity and progression of tubal pregnancy. CT invasion is a key histopathological feature that mediates local tissue destruction and interacts with vascular structures, contributing to both clinical manifestations and complications[6]. Understanding the interplay between microbial colonization, inflammation, and CT invasion is critical for predicting disease progression and tailoring clinical management[7].

Aim of the Study

The aim of the study was to investigate the morphological and microbiological features of cytotrophoblastic invasion in various pathogenetic variants of tubal pregnancy and to assess their significance for predicting clinical complications.

Materials and Methods

The study included 75 women diagnosed with tubal pregnancy, who were admitted to the gynecological department of a tertiary care hospital. The patients' age ranged from 18 to 42 years, with the majority in reproductive age.

Microbiological assessment included:

- Bacterial and viral cultures of the fallopian tubes;
- Cervical canal sampling for microbial colonization;
- Identification of common pathogens, including **Ureaplasma**, **Mycoplasma**, and herpes simplex virus.

Histopathological analysis was performed to evaluate:

- Presence and depth of cytotrophoblastic invasion;
- Involvement of specific layers of the fallopian tube (endosalpinx, myosalpinx, and full-thickness);
- Microvascular alterations and hemorrhagic changes associated with CT infiltration.

Clinical correlation involved:

- Assessment of intraoperative findings (e.g., tubal rupture, hematosalpinx);
- Documentation of hemorrhagic events;
- Correlation with implantation site and depth of invasion.

Results

Microbiological Findings

Microbial colonization of the fallopian tubes was detected in **69%** of patients, with **72%** showing signs of acute inflammation. Cervical canal infection was identified in only **41%** of cases. The most frequently isolated pathogens were Ureaplasma, Mycoplasma, and herpes simplex virus.

The high prevalence of microbial colonization emphasizes the role of infection in creating a pro-inflammatory environment that can predispose to tubal damage and ectopic implantation.

Cytotrophoblastic Invasion

Cytotrophoblastic (CT) invasion was observed in **67 cases (89.3%)**. Distribution by layers of the fallopian tube wall was as follows:

- **Endosalpinx only:** 12 cases
- **Myosalpinx involvement:** 14 cases
- **Full-thickness invasion (all layers):** 41 cases

Distribution of CT invasion by pathogenetic variant:

- **Progressive tubal pregnancy:** Endosalpinx – 11%, Myosalpinx – 56%, All layers – 33%
- **Tubal abortion:** Endosalpinx – 17%, Myosalpinx – 26%, All layers – 57%
- **Tubal pregnancy with rupture:** Endosalpinx – 10%, Myosalpinx – 23%, All layers – 67%

At early gestational stages, extra-villous CT invasion is primarily confined to the stroma of the endosalpinx. Interstitial CT involvement is associated with

micro-hemorrhages and localized tissue destruction, which may progress to hematosalpinx formation or tubal rupture.

Clinical Correlations

- Progressive CT invasion correlates with a higher risk of tubal wall damage and massive hemorrhage.
- Implantation at the apical fold of the mucosa increases the distance of CT penetration across all layers, promoting severe complications.
- Microbial colonization contributes to inflammatory activation and predisposes to structural compromise of the tube, enhancing the severity of clinical manifestations.

These findings demonstrate that **the interplay between infection, inflammation, and CT invasion is central to the pathogenesis and clinical course of tubal pregnancy.**

Discussion

The study confirms that microbial colonization of the fallopian tubes is highly prevalent in patients with tubal pregnancy (69%), with acute inflammatory signs in 72% of cases. This emphasizes the need for preventive antibacterial and anti-inflammatory therapy to reduce the risk of complications such as:

- Salpingitis
- Tubal obstruction
- Recurrent ectopic pregnancy

CT invasion patterns vary according to the pathogenetic variant and significantly influence clinical outcomes. Full-thickness invasion is more frequent in tubal abortion and tubal rupture, while myosalpinx-limited invasion predominates in progressive tubal pregnancies. The depth of CT invasion, combined with the site of implantation, predicts hemorrhagic risk and structural damage to the tube.

The high incidence of microbial colonization and inflammatory changes highlights the synergistic effect of infection and CT invasion in promoting tissue destruction and adverse clinical outcomes.

Conclusion

Tubal pregnancy is characterized by:

- High frequency of microbial colonization of the fallopian tubes (69%)
- Presence of acute inflammation in the majority of cases (72%)
- High prevalence of cytotrophoblastic invasion (89.3%), with variable depth depending on the pathogenetic variant

The findings underline the clinical significance of early microbiological assessment and histopathological evaluation of CT invasion. Preventive antibacterial and anti-inflammatory therapy, combined with careful monitoring of CT invasion patterns, is essential for reducing the risk of complications, including hemorrhage, hematosalpinx formation, and recurrent ectopic pregnancy.

Comprehensive understanding of these morphological and microbiological aspects allows for better risk stratification, individualized patient management, and improved reproductive outcomes.

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