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COMPARATIVE DIAGNOSTIC VALUE OF DIFFERENT BIOMATERIALS FOR DETECTION OF TORCH PATHOGENS

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Abstract: TORCH infections represent a significant global health problem due to their association with congenital anomalies, fetal developmental disorders, and neonatal morbidity. The TORCH complex includes *Toxoplasma gondii*, Rubella virus, Cytomegalovirus (CMV), Herpes simplex virus (HSV), and other infectious agents capable of transplacental transmission during pregnancy. These pathogens can cause severe complications such as miscarriage, intrauterine growth restriction, congenital malformations, neurological impairment, and neonatal mortality.

The aim of this study was to evaluate the comparative diagnostic value of different biomaterials for the detection of TORCH pathogens. Various biological samples including blood serum, saliva, urine, placental tissue, and amniotic fluid were analyzed using modern laboratory diagnostic methods such as enzyme-linked immunosorbent assay (ELISA) and polymerase chain reaction (PCR).

The results demonstrated that molecular diagnostic methods, particularly PCR, provide significantly higher sensitivity and specificity compared with conventional serological testing. Non-invasive biomaterials such as saliva and urine showed high diagnostic value for detecting cytomegalovirus infection, whereas amniotic fluid analysis was particularly informative for detecting fetal infection caused by *Toxoplasma gondii*. The findings highlight the importance of selecting appropriate biomaterials and combining serological and molecular diagnostic techniques to improve early detection of TORCH infections.

Keywords: TORCH infections, congenital infections, biomaterials, molecular diagnostics, ELISA, PCR, prenatal screening.

Introduction

Congenital infections remain one of the leading causes of neonatal morbidity and mortality worldwide. Among these infections, the TORCH complex plays a particularly important role due to its ability to cause severe fetal damage during pregnancy. The term TORCH refers to a group of pathogens including *Toxoplasma gondii*, Rubella virus, Cytomegalovirus, Herpes simplex virus, and other infectious agents such as *Treponema pallidum* and Parvovirus B19.

These pathogens share several biological characteristics, most notably their ability to cross the placental barrier and infect the developing fetus. Vertical transmission may occur during different stages of pregnancy, and the severity of fetal damage often depends on the gestational age at the time of infection.

Infections acquired during early pregnancy are more likely to result in severe congenital abnormalities or fetal loss. Clinical manifestations of congenital TORCH infections may include intrauterine growth restriction, hepatosplenomegaly, microcephaly, intracranial calcifications, hearing loss, visual impairment, and developmental delay.

Early diagnosis of TORCH infections plays a crucial role in preventing adverse pregnancy outcomes. Laboratory diagnosis is usually based on the detection of pathogen-specific antibodies or nucleic acids in biological samples obtained from pregnant women or newborns.

Serological testing using enzyme-linked immunosorbent assay (ELISA) is widely used for detecting IgM and IgG antibodies against TORCH pathogens. However, serological tests may have limitations, particularly during the early stages of infection when antibody levels remain low.

Advances in molecular biology have introduced highly sensitive diagnostic methods such as polymerase chain reaction (PCR), which allows direct detection of pathogen DNA or RNA in biological samples.

The choice of biomaterial significantly affects diagnostic accuracy. Different pathogens may be detected more effectively in specific biological samples. Therefore, evaluating the diagnostic value of various biomaterials is essential for optimizing laboratory detection of TORCH infections.

The aim of this study was to compare the diagnostic significance of different biomaterials used for detecting TORCH pathogens and to evaluate the effectiveness of serological and molecular diagnostic methods.

Materials and Methods

Study Design

The study involved a comparative analysis of laboratory diagnostic methods used for detecting TORCH pathogens in various biological materials obtained from patients suspected of congenital infections.

Biomaterials Analyzed

The following biological materials were examined:

- Blood serum
- Saliva
- Urine
- Amniotic fluid
- Placental tissue

These samples were selected because they represent the most commonly used materials in prenatal and neonatal diagnostics.

Diagnostic Methods

Serological Testing

Serological analysis was performed using enzyme-linked immunosorbent assay (ELISA) to detect pathogen-specific IgM and IgG antibodies.

Molecular Diagnostic Methods

Polymerase chain reaction (PCR) was used to detect pathogen DNA or RNA in biological samples.

PCR analysis provides high sensitivity and specificity and allows detection of infections even during early stages.

Table 1

Diagnostic value of biomaterials

Biomaterial	Diagnostic method	Advantages	Limitations
Blood serum	ELISA	Detects IgM and IgG antibodies	Limited sensitivity in early infection
Amniotic	PCR	High diagnostic accuracy	Invasive procedure

Biomaterial	Diagnostic method	Advantages	Limitations
fluid		for fetal infection	
Placental tissue	PCR / histology	Direct detection of pathogen	Limited availability
Saliva	PCR	Non-invasive sampling	Lower pathogen concentration
Urine	PCR	Effective for CMV detection	Requires laboratory processing

Results

The comparative analysis revealed significant differences in diagnostic sensitivity depending on the biomaterial analyzed.

PCR-based molecular diagnostics demonstrated higher sensitivity compared with serological methods. Detection of pathogen DNA allowed identification of infections during early stages when antibody levels were not yet detectable.

Cytomegalovirus infection was most frequently detected in saliva and urine samples, confirming the diagnostic value of these non-invasive biomaterials.

Rubella virus infection was mainly identified through serological testing due to the presence of specific antibodies in blood serum.

Toxoplasma gondii DNA was primarily detected in amniotic fluid samples, indicating fetal infection through transplacental transmission.

Table 2

Detection rates of TORCH pathogens in different biomaterials

Pathogen	Blood serum	Saliva	Urine	Amniotic fluid	Placental tissue
Toxoplasma gondii	Moderate	Low	Low	High	Moderate
Rubella virus	High	Low	Low	Moderate	Low
Cytomegalovirus	Moderate	High	High	Moderate	Moderate
Herpes simplex virus	Moderate	Low	Low	Moderate	Moderate

Discussion

The results of this study demonstrate that the diagnostic value of biomaterials varies significantly depending on the pathogen and diagnostic method used.

Molecular diagnostic techniques such as PCR have significantly improved the detection of TORCH infections due to their high sensitivity and specificity.

Non-invasive biomaterials such as saliva and urine are particularly useful for detecting congenital cytomegalovirus infection. These samples are easy to collect and suitable for neonatal screening.

Amniotic fluid remains one of the most reliable biomaterials for confirming fetal infection during pregnancy. However, its collection requires invasive procedures.

Therefore, the most effective diagnostic strategy involves combining serological and molecular diagnostic methods with analysis of multiple biomaterials.

Scheme

TORCH infection complex

TORCH infections

- T–Toxoplasma gondii
  intracellular protozoan parasite
- O – Other infections
  syphilis, parvovirus B19
- R – Rubella virus
  RNA virus
- C – Cytomegalovirus
  DNA virus (Herpesviridae)
- H – Herpes simplex virus HSV-1 / HSV-2

Conclusion

TORCH infections represent a complex group of congenital infections caused by pathogens with diverse biological characteristics.

The results of this study demonstrate that molecular diagnostic methods such as PCR provide higher sensitivity compared with traditional serological testing.

The diagnostic value of biomaterials varies depending on the pathogen. Non-invasive biomaterials such as saliva and urine show high diagnostic potential, particularly for detecting cytomegalovirus infection.

Combining multiple biomaterials with advanced molecular diagnostic techniques significantly improves the accuracy of TORCH infection detection and contributes to more effective prenatal screening programs.

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