Original Research

The effect made by the vaginal microbiome on pregnancy outcome

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Abstract

This article considers the effect made by the vaginal microbiome on the outcome of pregnancy. The vaginal microbiome is important for the health of a woman's reproductive system and can affect some critical aspects of pregnancy such as the development of preeclampsia and the likelihood of premature birth. This study is based on an analysis of the composition of the microbiome in pregnant women and the correlation of the data obtained with the outcomes of their pregnancy. The results of the study can help in the development of new approaches to predictive diagnostics and treatment of possible pregnancy complications caused by changes in the vaginal microbiome.

Keywords

Vaginal microbiome, Pregnancy outcome, Preeclampsia, Premature birth, Reproductive health, Prognostic medicine

Imprint

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Introduction

The vaginal microbiome is a complex community of microorganisms that plays an important role in maintaining the health of a woman's reproductive system. This microbiome consists of bacteria, fungi, viruses and archaea, with various species of Lactobacilli being dominant. The main function of these microorganisms is to maintain the acidic environment of the vagina, which prevents from the development of pathogenic flora and maintains the health of the woman. The composition of the microbiome can vary depending on age, hormonal levels, general health, hygiene habits, diet and many other factors. Recent research suggests that changes in the vaginal microbiome may influence the pregnancy outcome. For example, vaginal dysbiosis is associated with an increased risk of premature birth, urinary tract infections, and even preeclampsia. Extensive scientific work in recent years has focused on studying the relationship between the composition of the microbiome and such serious complications as preeclampsia and premature birth. Research has shown that certain types of microorganisms, such as Gardnerella vaginalis and Atopobium vaginae, are associated with a high risk of developing inflammatory diseases and may contribute to early labor. Also, the normal vaginal flora, rich in Lactobacilli, is usually correlated with a favorable pregnancy outcome. In this context, the present study aims to gain a better understanding of how variations in the microbiome can be used to predict and possibly prevent from pregnancy complications, thereby improving the outcomes for the mother and her child. An introduction to this topic requires a comprehensive analysis of current evidence data and systematization of information to identify potential biomarkers and therapeutic targets.

Material and Methods

Description of the sample

For this study, a sample of pregnant women between 18 and 40 weeks has been selected. The inclusion criteria for the study have been identified as follows:

- Age from 18 to 45 years;
- Singleton pregnancy;
- No chronic diseases such as diabetes, hypertension or cardiovascular disease.

The exclusion criteria applied to the study have covered the following:

- A history of serious complications during the current pregnancy (eg, preeclampsia);
- Use of antibiotics or other drugs that affect the microbiome in the last three months before the start of the study;
- Immunodeficiency conditions or receiving immunosuppressive therapy.
Methods for collecting and analyzing vaginal microbiome samples

Vaginal secretion samples were collected using sterile cotton swabs, which were inserted to a depth of 2-3 cm from the vaginal opening. The samples were stored in special containers at -80°C before their test analysis. To analyze the microbiome, the new generation sequencing (NGS) technology was used, which allowed us to determine the species composition and quantitative content of microorganisms in the samples. Particular attention was paid to the identification and quantification of lactobacilli and other relevant bacteria.

Statistical methods for data assessment

For our statistical analysis of data, methods of descriptive statistics were applied, as well as those of inferential statistics to compare the groups. Logistic regression and multiple regression analyses were utilized to assess relationships and correlations between the microbiome and the pregnancy outcomes. The Bonferroni method was used to adjust for multiple comparisons. The significance level for all statistical tests was established to be $p < 0.05$. All calculations were performed using the statistical package R and Python with the Pandas and SciPy packages.

These methods provide reliable and valid data on the relationship and the correlation between the vaginal microbiome and the pregnancy outcomes, which is a key to achieving the goals of this study.

RESULTS

Basic data on the composition of the microbiome

The study covered 100 pregnant women, of whom 50 had a normal pregnancy outcome and the other 50 experienced complications including preeclampsia and preterm birth. The microbiome analysis showed significant differences in composition between the two groups of the test subjects.

In the normal pregnancy outcome group, Lactobacilli predominated, especially Lactobacillus crispatus and Lactobacillus gasseri species, which are associated with maintaining an acidic environment and general vaginal health. While in the complications group, there was a significant increase in the diversity of microorganisms, including an increase in Gardnerella vaginalis and Atopobium vaginae, which are often associated with the development of bacterial vaginosis and other inflammatory conditions.

Comparative analysis of microbiome

Our statistical analysis has shown that the presence of high microbiome diversity and a decrease in the share of Lactobacilli correlate with an increased risk of pregnancy complications. The women with a predominance of Lactobacilli were 60% less likely to experience preeclampsia and 75% less likely to experience preterm birth, compared with the women with lower levels of the above bacteria. In addition, the use of multiple regression analysis allowed the identification of Gardnerella vaginalis and Atopobium vaginae as potential biomarkers for predicting the risk of complications. The significance level for those relationships was $p < 0.01$, highlighting their statistical significance. These results underline the importance of the vaginal microbiome composition as a potential factor influencing the pregnancy outcome. The findings can be used to develop preventive measures and therapeutic strategies to improve pregnancy outcomes based on modification of the vaginal microbiome in subgroups of women showing a high risk of complications.

DISCUSSION

Interpretation of the results obtained

The results of our study confirm and complement the existing evidence data on the influence made by the vaginal microbiome on the pregnancy outcome. Previous research suggests that a healthy vaginal microbiome, which is dominated by Lactobacilli, is associated with a low risk of preeclampsia, preterm birth, and infectious complications during pregnancy. Our study has shown that a decrease in the share of Lactobacilli and an increase in opportunistic pathogens such as Gardnerella vaginalis and Atopobium vaginae correlate with a greater likelihood of pregnancy complications.

Theoretical and practical implications

These results have important theoretical and practical implications for pregnancy monitoring and management. For example, they highlight the need to develop some new strategies for early diagnostics and intervention, which may include regular monitoring of the vaginal microbiome composition during preg-
nancy. Such approaches may help prevent from or reduce the risk of serious complications, thereby providing better outcomes for the mother and her baby.

Possible mechanisms of microbiome influence

Possible mechanisms through which the vaginal microbiome may influence the pregnancy outcome include its role in modulating the host immune response, impacting a local inflammation, and maintaining the mucosal barrier function. For example, Lactobacilli produce lactic acid, which helps maintain an acidic vaginal environment, preventing from pathogen colonizing. On the other hand, an increase in the number of pathogenic bacteria can contribute to the development of inflammatory processes that elevates the risk of premature birth. These conclusions may provide the basis for the development of targeted therapeutic strategies aimed at adjusting the composition of the vaginal microbiome to improve the pregnancy outcomes. This may involve the use of probiotics, prebiotics, or even microbiological therapies to restore and maintain the healthy vaginal microbiome.

Implications for clinical practice

Practical application of research results

The results of this study have important clinical implications for pregnancy management and preparation for childbirth. Determining the optimal composition of the vaginal microbiome may be a key aspect in antenatal care. This may include the following aspects:

1. Regular screening of the vaginal microbiome during pregnancy. Routine microbiome testing can help identify women at high risk of complications, allowing an early intervention.
2. Use of personalized probiotic supplements. Based on the specific microbiome, customized probiotic regimens can be developed to maintain or restore the normal vaginal flora.
3. Increasing the knowledge and awareness of patients. Improving awareness of the pregnant women about the importance of maintaining their healthy microbiome and the possibility of correcting it via diet and lifestyle.

Development of clinical guidelines

Based on the above research data, new clinical guidelines may be developed, including the following:

- Criteria for vaginal microbiome screening;
- Intervention protocols when revealing dysbiosis;
- Diet and lifestyle recommendations to maintain the healthy microbiome.

These clinical practices can become an integral part of standard antenatal care, helping to reduce pregnancy complications and improve the outcomes for the mother and her baby.

CONCLUSION

Key findings of the study

The study confirmed the significant role of the vaginal microbiome in determining the pregnancy outcome. It has been found that pregnancies with the normal outcome are more often correlated with a large share of Lactobacilli, while complicated pregnancies are related with a greater share of opportunistic microorganisms such as Gardnerella vaginalis and Atopobium vaginae. These evidence data highlight the importance of maintaining the healthy vaginal microbiome to prevent from pregnancy complications.

Recommendations for further research

Based on the results obtained, several areas for future research can be identified as listed below:

1. Continued study of the mechanisms of microbiome influence on reproductive health. It is necessary to study in more detail how changes in the vaginal microbiome affect the immune response and inflammatory processes in the body of a pregnant woman.
2. Development and testing of probiotic and prebiotic therapies. Studying the possibilities of using probiotics to improve and maintain the healthy microbiome may become a promising way for the prevention from complications.
3. Development of methods for early identification of risks. Creation of diagnostic tests based on the analysis of the vaginal microbiome, which may help in the early diagnostics of potential risks of pregnancy complications.
4. Study of the influence of lifestyle and nutrition on the vaginal microbiome. Understanding of how lifestyle and dietary factors influence the microbiome composition can help develop recommendations for pregnant women to maintain their healthy microbiome.

These areas of research will not only assist in a better understanding of the effect made by the microbi-
ome on the pregnant woman health and the pregnancy outcomes, but also to contribute to the development of new approaches to the prevention and treatment of complications.

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