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Study on the Clinical Significance and Expression Level of CA-125 and D-dimer in the Serum of Patients with Adenomyosis

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Abstract: CA-125 and D-dimer show potential applications in diagnosing and managing adenomyosis. As a traditional tumor marker, CA-125 may show a trend of increase in patients with adenomyosis, but its specificity is insufficient, because it may also increase in various gynecological diseases. As a measure of coagulation activity, D-dimer may be associated with inflammation and tissue changes related to adenomyosis. However, its specific mechanism of action and diagnostic efficacy still need to be further studied. Current studies are limited by the small sample size, insufficient standardization and lack of dynamic monitoring data, these factors limit the general applicability of the conclusions and practical value of the application. Therefore, it is particularly urgent to conduct large-scale, prospective studies to verify the effectiveness of these biomarkers and to explore their combined application in the diagnosis and management of adenomyosis. This will help to develop more accurate diagnosis and treatment plans and enhance the scientificity of clinical decision-making.

Keywords: Adenomyosis; CA-125; D-Dimer; Clinical significance; Diagnosis

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1. Introduction

Adenomyosis is a common disease in the field of gynecology, which is characterized by the invasion of endometrial tissue into the uterus and heterometrium. Such pathological changes usually lead to the expansion of the uterine volume and trigger a range of clinical symptoms, including chronic pelvic pain, excessive menstruation, and prolonged menstrual periods. These symptoms not only affect the physical health of patients but also seriously interfere with their quality of life and mental health [1–3]. Traditionally, the diagnosis of adenomyosis has mainly relied on imaging techniques, such as ultrasonography and magnetic resonance imaging (MRI) [1,3,4]. Although these methods can provide exhaustive information on the uterine structure, there may be a problem of insufficient accuracy in detecting small focal lesions of adenomyosis. Moreover, the high cost of high-end imaging examinations such as MRI limits its widespread application, especially in resource-limited areas [3,4].

In this context, the researchers gradually focus on serum biomarkers, hoping to assist in the diagnosis of adenomyosis through simple blood tests. CA-125 and D-dimer are two markers widely studied. As a tumor

marker, CA-125 was used early in the detection of ovarian cancer, but it also showed an elevation in some benign gynecological diseases. The D-dimer is the product of fibrin degradation and is mainly used to assess the thrombotic state. Preliminary studies showed that these two markers may have some diagnostic and monitoring value in patients with adenomyosis [1–3]. However, its clinical application needs more systematic and comprehensive studies. These biomarkers are expected to be a powerful complement to traditional diagnostic methods, providing a more convenient and potentially cost-effective approach to diagnosis [1,2].

2. CA-125 in adenomyosis

CA-125 is a glycoprotein antigen that was initially used to monitor ovarian cancer, but its elevated levels are also observed in a variety of gynecologic diseases. In recent years, researchers have begun to focus on the performance of CA-125 in adenomyosis, and have tried to evaluate its potential as a diagnostic and monitoring tool. In patients with adenomyosis, the levels of CA-125 are usually higher than those in normal women. This phenomenon is mainly due to uterine tissue inflammation and endometriotic stimulation caused by the disease, resulting in the increased release of CA-125. Several studies have shown that there is a correlation between elevated CA-125 and the degree of lesions of adenomyosis, that is, CA-125 levels may increase with the aggravation of the disease [3,5–7]. Therefore, CA-125 can reflect the activity and severity of the disease to some extent [3,5–7].

However, CA-125 also has limitations as a diagnostic marker. First, its sensitivity and specificity are not ideal in the diagnosis of adenomyosis. CA-125 can also be elevated in many other conditions, such as pelvic inflammatory diseases, endometriosis, and other uterine fibroid lesions. This limits the usefulness of CA-125 in distinguishing adenomyosis from other diseases. Therefore, relying on CA-125 alone for diagnosis may lead to misdiagnosis or missed diagnosis. Nevertheless, CA-125 is regarded as a potential auxiliary diagnostic tool, especially when combining imaging, to provide more diagnostic information. In addition, CA-125 can also be used to assess efficacy and monitor confirmed patients, judging the effectiveness of treatment and the course of the disease by regularly testing changes in their levels [3,6].

Overall, although CA-125 cannot be used as a diagnostic criterion for adenomyosis alone, its potential value cannot be ignored in the multidisciplinary diagnosis and treatment model. Future studies should continue to explore how to optimize the application strategy of CA-125 and its effects in combination with other biomarkers [1,7].

2.1. CA-125 expression in the blood of adenomyosis patients

In the study of adenomyosis, several key studies have explored the level changes of CA-125 in patient serum and its clinical significance. Overall, CA-125 levels were increased in patients with adenomyosis compared to healthy individuals. However, the specific degree of elevation and fluctuation range of CA-125 in such patients may vary between the study subjects and methods [1,3,7].

Some studies have shown that the mean CA-125 level in adenomyosis patients is generally above the upper limit of normal reference values (usually 35 U/mL), but the specific elevated levels may vary by individual differences and disease activity. For instance, Chen et al. [3] reported that levels often exceed 100 U/mL in severe cases, while Liu et al. [6] emphasized the variability due to patient-specific factors such as comorbidities and lesion severity. Studies have suggested that some patient's CA-125 levels may be only mildly elevated, while others may be significantly elevated to above 100 U/mL. However, this elevation is not unique to adenomyosis, as other gynecological diseases may also contribute to CA-125 elevation [1,7,8]. When exploring the level of CA-125 among different patient groups, studies found that factors such as patient age, disease duration length, lesion site and degree of lesion may all influence the level of CA-125 [9]. For example, patients with more disease or a larger range of lesions often have higher CA-125 levels. This may be due to the increased release of CA-125 [6,9,10]. Furthermore, changes in CA-125 levels may be even more complicated in patients with complications or complicated with other gynecologic diseases [10]. This suggests that, although

elevated CA-125 is associated with adenomyosis, it does not alone serve as a criterion for determining disease severity [11]. In conclusion, despite the application of CA-125 in adenomyosis, its multifactorial elevated levels and high interpatient variability limit its independent diagnostic role. Therefore, in clinical practice, CA-125 is usually used in combination with other diagnostic methods to improve diagnostic accuracy and comprehensively evaluate the changes in the condition. Future studies need to continue to explore how to more precisely utilize the diagnostic and surveillance value of CA-125 in different patient populations [3,6,10].

2.2. Test method

The main techniques used for detecting CA-125 include the enzyme-linked immunosorbent assay (ELISA) and the chemiluminescence immunoassay (CLIA) [12]. Studies comparing these methods suggest that CLIA offers higher sensitivity and automation, making it more suitable for large-scale clinical applications, while ELISA remains a cost-effective and widely available option in resource-limited settings [13]. Both methods are widely used in clinics and research to detect CA-125 levels in serum. The following is a comparison of the two techniques and their impact on the consistency and comparability of the test results [14–16].

2.2.1. Enzyme-linked immunosorbent test (ELISA)

(1) Advantage:

(a) Widely used: ELISA is a mature and widely used technology with a standardized operation process.

(b) Cost-effectiveness: Relatively low cost, so that it can be implemented in a resource-limited environment.

(c) Flexibility: Suitable for testing in multiple sample types (such as serum, plasma, etc.).

(2) Disadvantage:

(a) Sensitivity and specificity: Not as high as some emerging technologies, such as CLIA.

(b) Complex operation: Multiple steps are required, including incubation and washing, and long operation time.

(c) Less signal amplification: Low detection sensitivity for low-concentration samples.

2.2.2. Chemiluminescence immunoassay (CLIA)

(1) Advantage:

(a) High sensitivity and specificity: High sensitivity and specificity chemiluminescence reaction.

(b) Automation: Usually integrated into a fully automated analyzer, reducing the error of manual operation.

(c) Fast: Short detection time, suitable for high-throughput sample detection.

(2) Disadvantage:

(a) High cost: Equipment and reagents are more expensive and may not apply to all laboratories.

(b) Equipment dependence: Specific instrument platforms are required, limiting the choice of laboratories.

2.2.3. Effect on the consistency and comparability of test results

CLIA usually provides high consistency with automated and accurate assays. However, the test results of ELISA may be more variable due to more steps and artificial variation. Besides, there is also a high comparability of CLIA test results. Direct comparability of CA-125 results, in different laboratories, especially across different testing techniques. Using the same set of standards and calibration procedures is an important means of improving comparability.

When selecting the testing technology, the laboratory should consider the sample processing capacity, cost, equipment availability, and the required test accuracy. For studies involving long monitoring or in clinical applications, consistency and comparability of results are critical. The use of uniform techniques or the development of rigorous standard operating procedures may help to reduce the differences between different detection methods.

2.3. Clinical significance

The clinical significance of CA-125 level in adenomyosis is mainly reflected in the following aspects:

(1) Auxiliary diagnosis and supporting information

Although CA-125 cannot be used alone to confirm adenomyosis, it can provide supportive information to help determine the direction of diagnosis in suspected patients. Combined with imaging examination, CA-125 may provide some reference value for diagnosis.

(2) Disease activity indication

In some cases, increased CA-125 levels may be associated with disease activity, although this is not absolute. Higher CA-125 levels may be associated with more severe symptoms or more extensive lesions.

(3) Assessment of treatment responsiveness

A reduction in CA-125 levels during treatment may indicate a positive response to treatment. This may be helpful in tracking improvements and in evaluating the effectiveness of treatment options.

(4) Disease monitoring

In long-term management, regular monitoring of CA-125 levels may help detect potential disease changes, with limited sensitivity and specificity, but trend changes may still be useful.

(5) Restrictions and the need for caution

Since other benign lesions and physiological conditions (such as menstrual cycle, inflammation, etc.) can also affect CA-125 levels, the results must be used in combination with other clinical information to avoid miscalculation.

Overall, the clinical significance of CA-125 in adenomyosis is limited but can be part of a comprehensive assessment in specific situations to help clinicians develop a more comprehensive treatment and management plan. Its application should always be combined with other diagnostic tools and clinical assessments to ensure accurate and reliable medical judgment.

3. D-dimer in adenomyosis

D-dimer is a fibrin degradation product, the levels of which are often used to assess thrombosis and fibrinolytic activity. In adenomyosis, the measurement of D-dimer is an exploratory area, but some studies have attempted to explore its potential role in inflammation and tissue remodeling processes.

3.1. Potential role of D-dimer in adenomyosis

(1) Inflammatory response indication

Adenomyosis is a disease associated with a chronic inflammatory response. The increased levels of D-dimer may reflect the underlying inflammatory activity and fibrin metabolic changes in patients with adenomyosis.

(2) Assessment of disease severity

Theoretically, the level of D-dimerization may be associated with the disease severity of adenomyosis. Higher D-dimer levels may suggest more extensive tissue damage or more active lesions. However, the clinical evidence for this aspect is still insufficient.

(3) Difference from other diseases

Due to the lack of specificity of D-dimers, measurement of D-dimer level alone is insufficient to diagnose adenomyosis but may provide a clue for disease differentiation in combination with other tests.

3.2. Limitations of the current study

Currently, studies on D-dimer in adenomyosis are limited and mostly small-scale or preliminary studies. Here are the limitations:

(1) Lack of large-scale studies

Most of the existing studies are small samples or observational studies, and a lack of large-scale clinical trials to verify the specific role of D-dimer in adenomyosis.

(2) Low specificity

D-dimer is a common marker of many pathological processes, with low specificity, and it is difficult to define the disease type only through its level changes.

(3) Individual variability

D-dimer levels may be affected by multiple factors such as age, and the presence of other inflammatory or thrombotic diseases, thus having limited value as a single indicator.

3.3. Future research direction

To better understand the role of the D-dimer in adenomyosis, future studies could consider:

(1) Conduct large-scale, multicenter clinical studies to evaluate the potential diagnostic and prognostic value of D-dimers in adenomyosis.

(2) Combined analysis with other biomarkers (e. g. CA-125) to improve diagnostic accuracy.

(3) Explore the correlation between changes in D-dimer level and imaging assessment and improvement of clinical symptoms.

In conclusion, although the use of D-dimer in adenomyosis still needs more research support, its role as a potential biomarker deserves further exploration.

3.4. D-dimer expression in the blood of adenomyosis patients

Regarding the expression changes of D-dimer in patients with adenomyosis, the available studies are relatively limited and the results are not completely consistent. However, several preliminary studies and clinical observations have attempted to analyze the changes in their levels in these patients and the underlying mechanisms behind them.

(1) Higher trend

Some studies have shown that D-dimer levels may be increased in patients with adenomyosis. This change may be related to the increase in fibrin metabolism induced by chronic inflammation. However, because of the lack of specificity of D-dimers, this elevation may similarly reflect other pathological processes, such as concurrent infection or inflammatory diseases.

(2) Relationship with the severity of the disease

Some studies have proposed that D-dimer levels may be associated with the severity of the disease and that higher D-dimer levels may indicate more severe tissue invasion or vascular abnormalities.

3.5. Data consistency across the different studies

Due to the complexity of adenomyosis and the diversity of factors influencing the D-dimer, the issue of data consistency between different studies is more prominent:

(1) Differences in sample size and design

Most of the existing studies are small samples or single-center studies, with small sample sizes and different study designs (such as inclusion criteria and detection methods), resulting in large differences in results.

(2) Factors affecting fibrin metabolism

Individual patient differences, comorbidities, treatment regimen and other factors will affect the D-dimer level and increase the inconsistency of data.

(3) Characteristics under specific pathological conditions

Under specific pathological conditions, the changes in D-dimer levels may show the following characteristics:

(a) Acute onset or complications: D-dimer levels may be significantly increased in the acute episode of adenomyosis or with an increased risk of infection or thrombosis.

(b) Changes after treatment: Some treatments (such as hormonal therapy or surgery) may lead to dynamic

changes in D-dimer levels. For example, in the short term after surgery, the D-dimer may rise and subsequently decline with recovery.

3.6. Summary

In conclusion, further studies are still needed to clarify the specific role of D-dimer and the characteristics of its level changes in adenomyosis. A larger and more rigorous study should be considered to explore their clinical significance in such patients and to try to use it in combination with other biomarkers to improve the accuracy and reliability of diagnosis and monitoring.

3.7. Test method

The detection of D-dimer is usually done by blood tests, mainly the following common methods:

(1) Enzyme-linked immunosorbent test (ELISA)

Features: This method is widely used in clinical laboratories and is favored for its high sensitivity and specificity.

Process: Use an antibody to D-dimer to measure the concentration by color development or luminescence through an enzymatic reaction.

(2) Immunoturbidimetry

Features: This method is relatively fast and is suitable for most conventional laboratories.

Process: D-dimer concentration was calculated from the antigen-antibody reaction.

(3) Fluoroimmunoassay

Features: High sensitivity and specificity, suitable for the need for accurate measurement.

Process: D-dimer level is detected by stimulating the fluorescence signal by laser using fluorescently labeled antibody.

(4) Overall blood analysis method

Features: Fast and convenient, often used for bedside detection.

Process: This method uses specific kits that can be tested within minutes, suitable for clinical settings requiring rapid decision-making.

3.8. Test precautions

(1) Sample processing: Strict blood sample processing is required to avoid hemolysis and other factors that may affect the test results.

(2) Interpretation of results: Comprehensive assessment combined with clinical context, as D-dimer level may be affected by various factors, such as age, pregnancy, and postoperative status.

(3) Comparability between different methods: Different detection methods may have different reference ranges and sensitivity, so the results may not be directly comparable.

In conclusion, the detection methods of D-dimer are diverse, each with its advantages and disadvantages, and clinicians need to choose appropriate methods according to specific situations and comprehensively interpret the results combined with other clinical information.

3.9. Immunometric turbidimetry

Immunoturbidimetry is based on antigen-antibody responses. When the D-dimer in the sample is bound to the specific antibody in the reagent, an immune complex forms, resulting in an increased turbidity of the solution. The D-dimer level in the sample can be quantified. Immunoturbidimetry is widely used because of its high specificity and sensitivity. It can provide reliable quantitative results in a relatively short period. In terms of the limitations, some methods may be affected by the high content of other proteins or substances with high solubility in the sample, resulting in background noise or interference.

3.9.1. Reproducibility

Immunoturbidimetry generally shows good reproducibility under laboratory conditions, especially in automated analyzers, enabling high throughput and high consistency detection. Instrument calibration and reagent batches may affect the repeatability of the results, requiring strict quality control measures.

3.9.2. Clinical utility

(1) Rapid and high throughput: The obibidimetric method rapidly provides results for hospital laboratories requiring large sample processing.

(2) High degree of automation: Suitable for integration into automated analysis equipment to reduce human error.

(3) Relatively low cost: Immunity is more economical than some more complex methods.

3.9.3. Application scenario

(1) Thrombosis assessment: Often used to assess the risk of VTE in patients.

(2) Treatment monitoring: Monitoring the efficacy of anticoagulation therapy and use in postoperative or acute condition monitoring.

3.9.4. Limitations

(1) Specificity: Although sensitive, the D-dimer lacks pathological specificity, and other diseases such as infection and inflammation may also lead to elevated levels, which need to be combined with clinical evaluation.

(2) Standardization: Kits provided by different equipment and reagent manufacturers may have different test results and need to be standardized and calibrated.

3.9.5. Conclusion

Immunoturbidimetry is commonly used in the clinic to detect D-dimer levels in the clinic because of its rapid, reliable and reproducible nature. In order to optimize its clinical application, enhanced standardization and quality control and comprehensive evaluation combined with other clinical information.

3.10. Clinical significance

D-dimer detection has many important applications and significance in clinical practice, mainly focusing on the following aspects:

(1) Diagnosis and exclusion of thrombotic disease

(a) Venous thromboembolism (VTE): Increased D-dimer levels are often associated with acute venous thrombosis (deep vein thrombosis and pulmonary embolism). Although its specificity is low, a highly sensitive negative predictive value helps to exclude VTE.

(b) Clinical strategy: D-dimer is often used in the screening of high-risk populations. If the D-dimer result is negative, it can effectively exclude thrombotic disease and reduce unnecessary imaging tests.

(2) Anticoagulation therapy was monitored

The dimer can be used to monitor the effect of the anticoagulation therapy. The decrease in D-dimer levels after treatment may indicate good efficacy.

(3) Auxiliary diagnosis of disseminated intravascular coagulation (DIC)

In DIC, D-dimer levels are usually significantly elevated. By combining other coagulation markers, the D-dimer can be used as an adjunct tool for the diagnosis and severity assessment of DIC.

(4) Assessment of surgery and after trauma

After surgery and severe trauma, D-dimer levels may increase due to increased tissue damage and the process of fibrinolysis. Therefore, D-dimer testing can help to assess blood coagulation after surgery or

trauma.

(5) Prediction of pregnancy complications

There is a natural tendency to increase the D-dimer levels during pregnancy, but the excessive elevation may indicate the risk of gestational complications, such as preeclampsia or placental abruption.

(6) Risk assessment of cardiovascular events

Some studies have shown that increased D-dimer levels may be associated with an increased risk of cardiovascular disease (myocardial infarction and stroke).

(7) Important considerations

Although D-dimer is very useful for screening and excluding certain diseases, its elevated levels lack specificity because many other conditions (inflammation, infection, trauma, surgery, pregnancy, etc.) can also lead to elevated D-dimer. Therefore, it is necessary to comprehensively evaluate the patient with the history, signs, and other laboratory or imaging findings. Results interpretation considers individual differences and clinical context and avoids a single reliance on D-dimer values to make diagnostic decisions.

In conclusion, D-dimer detection is important in clinical practice and can effectively assist in the diagnosis, monitoring and risk assessment of multiple pathological conditions. However, in order to make accurate clinical judgments, the multifaceted information must be considered comprehensively.

4. Discussion

The application of D-dimer in adenomyosis and other related pathological states needs to be considered, including the biological properties of D-dimer, its changing mechanisms in different disease states, and how this information can be used effectively in the clinic.

4.1. Biological characterization of the D-dimer

The D-dimer is a product of fibrin degradation and is commonly used to assess coagulation and fibrinolytic activities in vivo. Normally, the levels of D-dimers are low, while their levels may be significantly elevated in pathological states, such as thrombosis, severe inflammation, or tissue damage.

4.2. Potential applications in adenomyosis

4.2.1. Diagnosis and monitoring

Challenge: The main symptoms of adenomyosis include excessive menstruation and dysmenorrhea, which are not specific, making it challenging to rely solely on pathological indicators.

Potential: If studies confirm that D-dimers present characteristic changes in patients with adenomyosis, they may provide auxiliary tools for diagnosis.

Dynamic monitoring: lesion progression or efficacy may be assessed by monitoring changes in D-dimer levels.

4.2.2. Pathophysiological understanding

(1) Local inflammation and hyperplasia: Adenomyosis involves local inflammation caused by the invasion of endometrioid glands and stroma into the myometrium. The D-dimers may reflect the fibrinolytic activity at the lesion.

(2) Systemic effects: If it changes in adenomyosis, it may reveal the impact of the disease on the systemic coagulation and fibrinolytic system.

(3) Markers of pathological status: During preeclampsia, the increase of D-dimer often indicates the placental pathological status and systemic intravascular coagulation.

(4) Clinical decision making: use dynamic changes of D-dimer to guide treatment and prevention measures.

(5) Inflammatory and thrombotic diseases: Widely used to assist in the diagnosis and exclusion of thrombotic disease by combining other clinical indicators and imaging evaluation with monitoring D-dimer levels in

chronic inflammatory disease as secondary indicators.

5. Clinical utility and research direction

5.1. Clinical integration

The use of the D-dimer as a monitoring indicator in the clinic requires a combination of medical history and other clinical data. A single value may lack sufficient information. Standardized measurement and interpretation criteria are crucial to avoid issues of comparability of different laboratory results.

5.2. Future research

Longitudinal studies of the D-dimer in adenomyosis, especially in other chronic diseases, should be expanded to understand its role in the disease process. Besides, future research should also explore the combined use of D-dimer with other inflammatory and biomarkers to improve the accuracy and effectiveness of its clinical application.

In conclusion, although the application of D-dimer in adenomyosis is not clear, its role in some diseases has been gradually recognized. Future studies may expand the scope of its application in different pathological states and improve its clinical value.

In the diagnosis of adenomyosis, CA-125 and D-dimers are possible biomarkers, each with different properties and potential for clinical application.

6. Potential research limitations

6.1. Comparison of CA-125 and D-dimer

The comparison of CA-125 and D-dimer is shown in **Table 1**.

Table 1. The comparison of CA-125 and D-dimer

	CA-125	D-dimer
Background	CA-125 is a glycoprotein antigen commonly used for ovarian cancer surveillance but is also elevated in a variety of benign lesions.	The D-dimer, as a fibrin degradation product, is commonly used to assess coagulation and fibrinolytic activity.
Sensitivity	CA-125 levels are often elevated in patients with adenomyosis and endometriosis. However, its sensitivity is not very high and may not be evident in early or mild adenomyosis.	In adenomyosis, the sensitivity of the D-dimer has not been fully studied, and its elevation may theoretically reflect enhanced fibrinolytic activity.
Specificity	CA-125 has low specificity because it may be elevated in many benign lesions and other gynecologic diseases (uterine fibroids, pelvic inflammatory diseases).	The specificity of D-dimers is low because multiple pathological states (infection, inflammation, recovery period after surgery) can increase them.
The potential for the combined use	Improve the diagnostic accuracy: Combining CA-125 with the D-dimer may improve the accuracy of the diagnosis of adenomyosis. CA-125 can provide insight into tumor markers, while D-dimers can reflect the underlying metabolic and fibrinolytic activity.	
Complementation	CA-125 is more focused on identifying tumor-related or ectopic endometrial tissue responses, while D-dimers may supplement information on coagulation abnormalities or tissue damage. The synergy may improve the ability to detect the pathological state of specific adenomyosis.	

6.2. Monitoring and management in clinical situations

6.2.1. Diagnosis and evaluation

Initial screening using CA-125 combined with D-dimers to exclude or confirm atypical conditions, especially if imaging findings are unclear.

6.2.2. Treatment follow-up

Treatment response can be assessed by monitoring changes in CA-125, and D-dimer changes may be estive of

fibrinolytic status and tissue recovery.

6.3. Prognostic assessment

The combined dynamic monitoring of CA-125 and D-dimers may be used for prognostic assessment to help predict the direction of the disease or the risk of recurrence.

7. Conclusion

The respective sensitivity and specificity of the CA-125 and D-dimers in the diagnosis of adenomyosis limits the usefulness of their separate application. However, the combination of both biomarkers may provide more comprehensive information on diagnosis, treatment monitoring, and prognostic assessment. However, the clinical application should be interpreted carefully, combined with the comprehensive clinical evaluation and other examination results, to ensure accuracy and reliability. Further studies are important to verify their combined diagnostic value and develop standardized application strategies.

In conclusion, CA-125 and D-dimers are potential biomarkers for adenomyosis. CA-125 has a role in labeling tumors and ectopic lining activity, but its specificity is limited. While D-dimer mainly reflects coagulation and fibrinolytic activities, its specific application in adenomyosis needs to be studied, which could theoretically provide complementary information on the status of the fibrinolytic system.

Combining these two markers, it is possible to improve the diagnostic accuracy of adenomyosis and enhance the understanding of the complexity of the condition through complementary effects. In clinical practice, this combined strategy can help improve diagnosis, treatment monitoring and prognostic evaluation, especially when imaging results are ambiguous or dynamic observation of disease changes is required.

Nonetheless, more studies are needed to validate and refine the specific methods and standards for the combined application to ensure the reliability and operability in different clinical contexts. Ultimately, this will help to provide more precise diagnostic and management strategies for patients in individualized medicine.

The current study suggests that CA-125 and D-dimer may have some potential for application in the diagnosis and management of adenomyosis, with limitations in their respective status and validity.

8. CA-125 and D-dimer in gynecological diseases

CA-125 has been identified in several studies as one of the potential markers of adenomyosis, and its elevation can suggest a similar tumor response or endometriotic activity. Although it shows some diagnostic value in some patients, it is not ideal when used alone due to its wide response and limited specificity in benign and malignant gynecological diseases.

D-dimer, as a commonly used measure of the coagulation–fibrinolytic balance in vivo, it could theoretically reflect the underlying inflammatory or tissue-remodeling activity in adenomyosis.

However, there are still few studies addressing its specific role in adenomyosis, and the evidence for clinical application is inadequate.

8.1. Lack of existing studies

(1) Small sample size: Due to the limited sample size, the universality and persuasion of the results in many studies are low.

(2) Lack of unified standards: There are differences in detection methods and interpretation of results among different studies, resulting in poor comparability of results.

(3) Lack of research on dynamic monitoring: There is a relative lack of long-term research on the dynamic changes and monitoring value during the treatment process.

(4) Insufficient research on joint application: There is insufficient research on how to effectively combine CA-125 and D-dimer for diagnosis and management.

(5) Calls for further research: To enhance the contribution of CA-125 and D-dimers in the diagnosis and

management of adenomyosis, prospective, large-scale studies are urgently needed. These studies will help to better define the role of CA-125 and D-dimer in adenomyosis, ultimately facilitating the development of a more precise, personalized diagnosis and treatment strategies.

Disclosure statement

The authors declare no conflict of interest.

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