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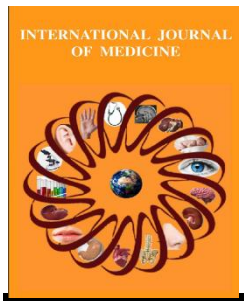

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Research Article

A Comparative Study of Serum Ascitic Albumin Gradient with Ascitic Fluid Total Protein in Evaluation of Different Causes of Ascites

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Abstract

Background: Background: Ascites is usually a sign of an underlying systemic or localized disease process, its etiology may vary from chronic liver disease and portal hypertension to malignancy, tuberculosis, nephrotic syndrome, and congestive heart failure. ***Objective***: A comparative study of serum ascitic albumin gradient (SAAG) with ascitic fluid total protein (AFTP) in evaluation of different causes of ascites. Methods: This cross-sectional study was conducted among all adult patients with ascites admitted to the Department of Medicine, RIMS Ranchi over a duration of 12 months. ***Result***: The study population's mean age was 45.3 years, and a larger percentage of patients (65.4%) were male. Cirrhosis was the most frequent cause of ascites (51.9%), followed by malignant ascites (11.5%) and tuberculous peritonitis (19.2%), confirming that liver illness is still the most common cause. Significant clinical and biochemical differences between the groups with high SAAG (>1.1 g/dL) and low SAAG (<1.1 g/dL) were discovered by the study. Indicating more severe liver failure, patients in the high SAAG group had higher serum bilirubin levels (4.1 mg/dL vs. 1.8 mg/dL, $p < 0.001$), higher serum ALT (75.0 U/L vs. 58.2 U/L, $p = 0.01$), and a greater prevalence of jaundice (77.4% vs. 23.8%). Additionally, serum creatinine was higher in the high SAAG group, suggesting renal impairment in cirrhotic patients. In contrast, low SAAG was more associated with infectious and malignant ascites, such as tuberculosis and malignancy ***Conclusion***: higher serum albumin (>3.0 g/dL) was protective against exudative ascites (OR = 0.4, $p = 0.01$). Age and gender were not significant predictors, reinforcing that biochemical markers remain the primary tools for classification.

Keywords: Serum Ascitic Albumin Gradient, Ascitic Fluid, Total Protein, Different Causes Of Ascites

Introduction:

The multitude of Ascites pathogenesis requires a precise and effective diagnostic workup to direct appropriate management and enhance patient outcomes. Biochemical analysis of ascitic fluid, obtained via paracentesis, plays a pivotal role in the initial evaluation of ascites. Among the numerous diagnostic tools available, the Serum Ascitic Albumin Gradient (SAAG) and biochemical ascitic fluid analysis, under paracentesis, occupies a central position in the initial ascites evaluation. Of the several diagnostic modalities at the disposal, two of the important parameters frequently used to distinguish between etiologies are the Serum Ascitic Albumin Gradient (SAAG) and Ascitic Fluid Total Protein (AFTP). SAAG, the difference between ascitic fluid albumin and serum albumin concentrations, is especially efficient in differentiating portal hypertension-

induced ascites from other etiologies. A SAAG value of ≥1.1 g/dL is highly suggestive of portal hypertension, as in liver cirrhosis and Budd-Chiari syndrome, while a SAAG <1.1 g/dL is indicative of non- portal hypertensive etiologies, like peritoneal carcinomatosis or tuberculosis1.

Conversely, AFTP separates ascitic fluid as transudative (low protein, <2.5 g/dL) or exudative (high protein, ≥2.5 g/dL), an old discrimination that gave clues to the underlying pathology. Nevertheless, its accuracy is frequently limited by superimposable levels of protein in many conditions, including malignancy and tuberculosis.

Notwithstanding widespread application of these parameters, their relative diagnostic precision and clinical value are still topics of current investigation and controversy. SAAG is highly specific for diagnosing portal hypertension, but little value in separating other causes of ascites. Likewise, although AFTP gives an approximate measure of the content of protein in ascitic fluid, it may not always accurately separate varied etiologies. This also highlights the requirement for a rigorous assessment of these markers to improve their use in clinical practice, especially in settings where resource limitations may prevent access to sophisticated diagnostic technologies.

In spite of the prevalent use of SAAG and AFTP, little is known from comparative studies on their diagnostic effectiveness over the entire range of ascitic causes. The majority of studies concentrate mainly on cirrhotic ascites, with a gap in knowledge about their functions in diseases such as malignancy, tuberculosis, and other non-hepatic etiologies of ascites. Furthermore, the algorithms for diagnosing ascites in low-resource areas, where complex imaging and molecular diagnostics might not be accessible, and are inadequately available.. This is most relevant in a tertiary care hospital such as the Rajendra Institute of Medical Sciences (RIMS), Ranchi, where the patients come with varied and intricate conditions.

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Materials and Methods

This cross-sectional study was conducted among all adult patients with ascites admitted to the Department of Medicine, Rajendra Institute of Medical Sciences (RIMS), Ranchi over a duration of 12 months

Inclusion Criteria

- Patients who provided informed consent or assent to participate in the study.
- Both male and female patients aged 18 years and older.
- All patients with ascites of any etiology not previously established.

Exclusion Criteria

- Pediatric cases or pregnant women.
- Patients with severe coagulopathy or disseminated intravascular coagulation (DIC).
- Ascitic patients with blunt abdominal injury.
- Patients undergoing diuretic therapy prior to ascitic fluid analysis.
- Patients with hepatic encephalopathy or acute gastrointestinal bleeding.

Sample Size

Sample Size calculation: n =(Z2 pq) / d2 Where,
n: sample size,
Z: 2 (considering confidence level to be 95%) p: prevalence
q: 1-p
d: precision
Sample Size in number: Taking p as7%2,3.4] , ,
d as 5%
n = (4×0.07×0.93) / (0.05×0.05)
= 104.16
= 104

Sampling technique – Consecutive sampling will be done for all the patients fulfilling above mentioned inclusion and exclusion criteria.

Sampling Technique

Consecutive sampling was used, including all patients meeting the inclusion and exclusion criteria.

Method of Sample Collection

- Blood Samples: Blood was drawn from the antecubital vein using clot-activator red vials under aseptic conditions. Samples were analyzed using the ERBA360 Biochemistry Analyzer.
- Ascitic Fluid Collection: Fluid was collected from two fingerbreadths anterior and medial to the anterior superior iliac spine in the left lower quadrant with the patient in a supine position [5].

Technique Of Paracentesis:

Sterile gloves need to be used while carrying out the procedure of abdominal paracentesis. Needle entry site and surrounding area anywhere in the quadrant need to be draped with pivot iodine solution. Local anaesthetic needs to be infiltrated in the entry site from skin to subcutaneous tissue. Z tract technique is employed to avoid leakage of the fluid from the needle entry site after the needle removal. According to this technique, the skin needs to be stretched 2 cm downward and then needle with syringe needs to be advanced, in the process plunger of the syringe being pulled back. The stretched skin needs to be released only when ascitic fluid flows in to the syringe and the needle enters the peritoneum. The needle needs to be advanced slowly in an increment of 5mm through anterior abdominal wall. Slow entry of the needle avoids damage to the bowel loops since it allows the bowel to get deflected away from the needle. Intermittent suctioning of the syringe needs to be done instead of continuous suctioning since the latter can create obstruction to the flow by sticking the bowel loop with the tip of the needle once it enters the peritoneum due to negative pressure. Approximately 30 ml of ascitic fluid is aspirated and sent for the above-mentioned diagnostic tests.

Data Collection and Analysis

Patients with ascites (both known and newly diagnosed) admitted to the General Medicine wards of RIMS Ranchi who consented to the study underwent the following assessments:

- Demographics: Age, sex, blood pressure.
- Laboratory Investigations:
    - Complete blood count: Hemoglobin, red cell count, RDW, WBC count, differential count, platelet count, mean platelet volume, peripheral blood smear.
    - Renal function tests: Blood urea, serum creatinine.
    - Blood sugar: Fasting and postprandial levels, HbA1C.
    - Serology: HIV, HBsAg, Anti-HCV.
    - Urine examination: Routine analysis, UPCR/UACR.
    - Lipid profile: Triglycerides, LDL cholesterol, HDL cholesterol.
    - Serum albumin.
    - Ascitic fluid analysis: Total protein, albumin, and SAAG (Serum-Ascitic Fluid Albumin Gradient).

Statistical Tools and Analysis

Template was generated in MS excel and Data analysis was done using SPSS Software version 25.0. A sample size of 104 was calculated in which we used 7% as a margin of error, 95% as confidence interval (CI). All continuous variables were described as a mean and standard deviation which were then compared. The comparison of categorical data was done either using Pearson' s coefficient. Multivariate logistic regression analysis was done for predicting exudative ascites. A p-value of <0.07 was considered statistically significant (two-tailed).

Results

A total of 104 ascitic patients were recruited into the study. The following tables give an overview of demographic, clinical, laboratory, and diagnostic findings comparing SAAG (Serum-Ascitic Albumin Gradient) and AFTP (Ascitic Fluid Total Protein) for assessing the etiology of ascites.

The study population had a mean age of 45.3 years, with a higher proportion of male patients (65.4%). The mean BMI was 23.5 kg/m², and the average duration of symptoms before presentation was approximately 4 months.

Table 1: Baseline Clinical and Laboratory Parameters by Saag Group

Parameter	Total	High SAAG	Low SAAG	p-value

	(n=104)	(n=62)	(n=42)	
Jaundice, n (%)	58 (55.8%)	48 (77.4%)	10 (23.8%)	< 0.001
Peripheral Edema, n (%)	36 (34.6%)	26 (41.9%)	10 (23.8%)	0.04
Serum Bilirubin (mg/dL)	3.2 ± 1.5	4.1 ± 1.2	1.8 ± 0.9	< 0.001
Serum ALT (U/L)	68.5 ± 30.2	75.0 ± 25.8	58.2 ± 28.4	0.01
Serum Creatinine (mg/dL)	1.2 ± 0.4	1.3 ± 0.5	1.0 ± 0.3	0.005

High SAAG patients also had significantly higher rates of jaundice and abnormal serum bilirubin than the low SAAG patients ($p < 0.001$). Liver enzymes (ALT) and serum creatinine were significantly elevated in the high SAAG group (reflecting higher liver damage in these patients)

Table 2: Etiological Distribution Of Ascites

Etiology	Number (n)	Percentage (%)
Cirrhosis	54	51.9
Cardiac Ascites	8	7.7
Nephrotic Syndrome	4	3.8
Tuberculous Peritonitis	20	19.2
Malignant Ascites	12	11.5
Other (e.g., Pancreatitis)	6	5.8

Cirrhosis was the most common cause of ascites (51.9%), followed by tuberculous peritonitis (19.2%) and malignant ascites (11.5%). This distribution reinforces the clinical relevance of differentiating between transudative and exudative ascites based on etiology.

Table 3: Comparison of Serum and Ascitic Fluid Biochemical Parameters

Parameter	Overall (n=104)	High SAAG (n=62)	Low SAAG (n=42)	p-value
Serum Albumin (g/dL)	2.8 ± 0.6	2.5 ± 0.5	3.2 ± 0.4	< 0.001
Ascitic Fluid Albumin (g/dL)	1.4 ± 0.3	1.1 ± 0.2	1.9 ± 0.3	< 0.001
Ascitic Fluid Total Protein (g/dL)	2.8 ± 1.2	2.1 ± 0.8	3.8 ± 0.9	< 0.001
SAAG (g/dL)	1.4 ± 0.4	1.5 ± 0.3	1.3 ± 0.4	0.002

There are statistically significant differences between the high and low SAAG groups. Patients with high SAAG had lower serum and ascitic albumin but also lower ascitic total protein compared to the low SAAG group. The significant difference in SAAG values ($p = 0.002$) supports its role in differentiating the etiology of ascites.

SAAG values were highest in patients with cirrhosis, cardiac ascites, and nephrotic syndrome—all conditions typically associated with transudative fluid. In contrast, patients with tuberculous and malignant ascites exhibited lower SAAG values, consistent with exudative ascites.

Table 4: Distribution of Ascitic Fluid Total Protein (AFTP) Among Different Etiologies

Etiology	Mean AFTP (g/dL) ± SD	Range (g/dL)
Cirrhosis	1.9 ± 0.5	1.0 – 2.5
Cardiac Ascites	2.2 ± 0.6	1.5 – 2.8
Nephrotic Syndrome	2.0 ± 0.4	1.5 – 2.3
Tuberculous Peritonitis	4.0 ± 0.8	3.2 – 4.8
Malignant Ascites	4.5 ± 0.7	3.8 – 5.2
Other	3.7 ± 0.6	3.0 – 4.3

The AFTP values were significantly lower in transudative conditions (cirrhosis, cardiac, and nephrotic syndrome) and higher

in exudative conditions (tuberculous, malignant, and other inflammatory etiologies). This pattern supports the use of AFTP as a complementary marker in the evaluation of ascites.

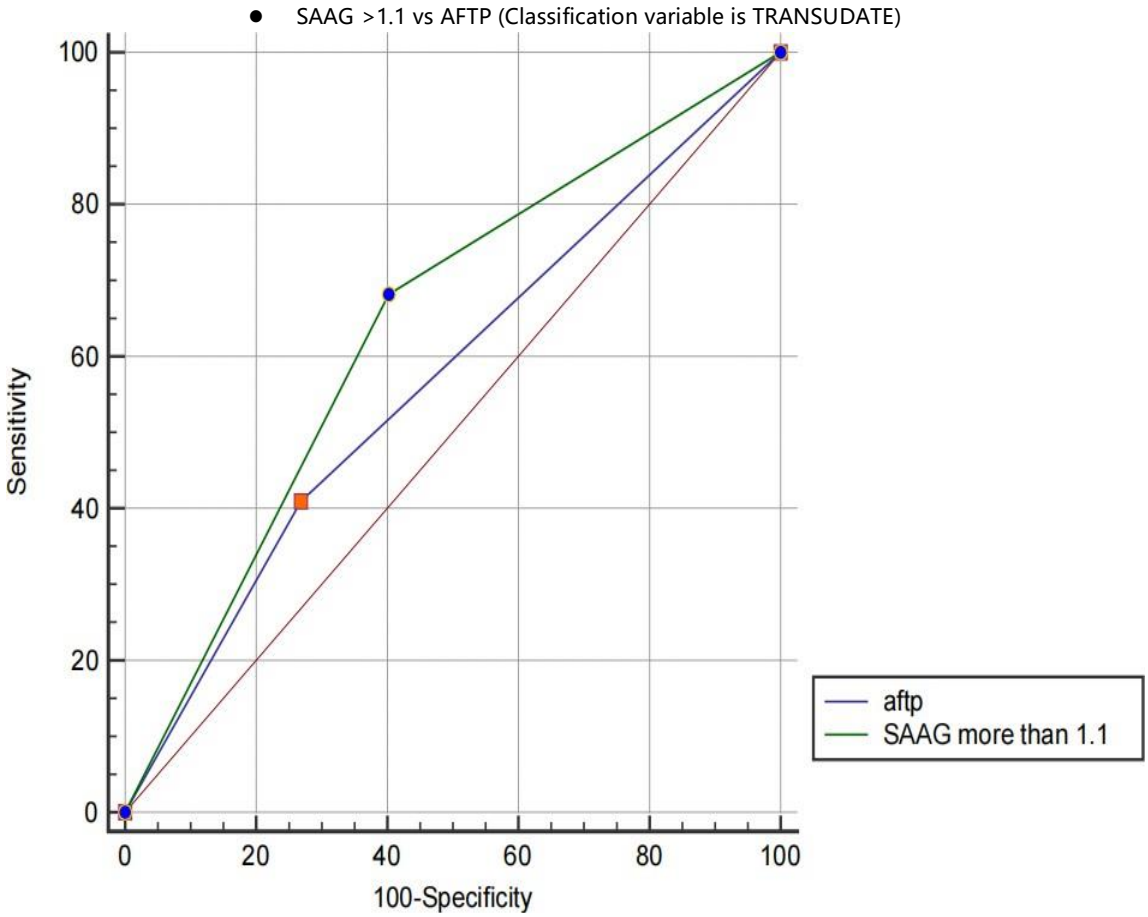
A moderate negative correlation exists between SAAG and AFTP (r = -0.45, p = 0.001), indicating that as SAAG increases, AFTP tends to decrease. Moreover, serum albumin shows an inverse relationship with SAAG (r = -0.52) and a positive relationship with AFTP (r = 0.48), further validating their roles in reflecting underlying pathophysiology.

Table 5: Diagnostic Performance of Saag and AFTP in Differentiating Transudative Vs Exudative Ascites

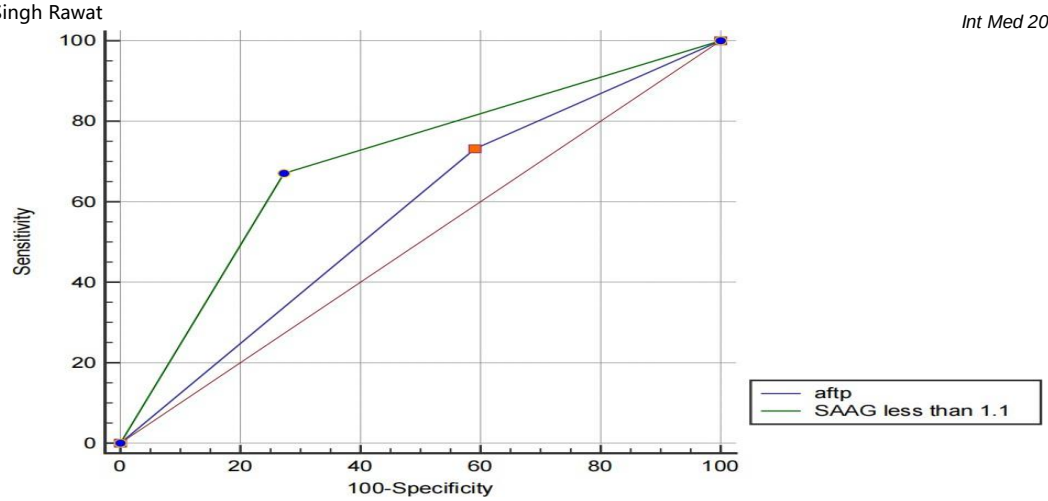
Parameter	SAAG (≥1.1 g/dL)	AFTP (≥2.5 g/dL)
Sensitivity (%)	92.3	78.4
Specificity (%)	88.1	65.2
Positive Predictive Value (%)	90.5	70.2
Negative Predictive Value (%)	90.0	72.1
Diagnostic Accuracy (%)	90.2	72.5

SAAG demonstrates higher sensitivity (92.3%) and specificity (88.1%) compared to AFTP (78.4% and 65.2%, respectively) for differentiating transudative from exudative ascites. The overall diagnostic accuracy of SAAG is also superior (90.2% vs. 72.5%), supporting its preferential use in clinical practice.

Comparison of ROC curves



ROC curve for estimated the diagnostic accuracy in patient of both SAAG and AFTP in ascites. ROC curve for SAAG specificity and sensitivity in pulmonary hypertension ascites with area under curve 0.570



SAAG <1.1 vs AFTP (Classification variable is EXUDATE

ROC curve for estimated the diagnostic accuracy in patient of both SAAG and AFTP in ascites. ROC curve for AFTP specificity and sensitivity in pulmonary hypertension ascites with area under curve 0.699.

Table 6: Comparison Of Mean Saag and AFTP Values in Transudative and Exudative Ascites

Parameter	Transudative Ascites (n = 70)	Exudative Ascites (n = 34)	p-value
Mean SAAG (g/dL)	1.6 ± 0.3	0.9 ± 0.2	< 0.001
Mean AFTP (g/dL)	1.8 ± 0.5	4.2 ± 0.7	< 0.001

There is a statistically significant difference between transudative and exudative ascites for both SAAG and AFTP. Patients with transudative ascites have significantly higher SAAG and lower AFTP values, while those with exudative ascites exhibit the opposite pattern ($p < 0.001$ for both).

Table 7: Multivariate Logistic Regression Analysis for Predicting Exudative Ascites

Variable	Odds Ratio (OR)	95% Confidence Interval (CI)	p-value
SAAG (< 1.1 g/dL)	5.2	2.1 – 12.8	< 0.001
AFTP (≥ 2.5 g/dL)	4.0	1.8 – 8.9	0.002
Serum Albumin (> 3.0 g/dL)	0.4	0.2 – 0.8	0.01
Age (per year increase)	1.03	0.99 – 1.07	0.12
Gender (Female)	0.8	0.4 – 1.7	0.65

In the multivariate logistic regression model, a SAAG value of < 1.1 g/dL and an AFTP value of ≥ 2.5 g/dL were significantly associated with exudative ascites (OR 5.2 and 4.0, respectively). A higher serum albumin level (> 3.0 g/dL) appears to be protective (OR 0.4). Age and gender did not show statistically significant associations in predicting exudative ascites.

Discussion

The mean age of participants was 45.3 years, with 65.4% male and 34.6% female patients. The most common cause of ascites was cirrhosis (51.9%), followed by tuberculous peritonitis (19.2%) and malignant ascites (11.5%).

The demographic characteristics of this study align with Sastry et al.6 and Gupta et al.7, where the mean ages were 48.2 and 50.1 years, respectively. The gender distribution was also similar.

Sensitivity, Specificity, and Diagnostic Accuracy of SAAG vs. AFTP

The present study demonstrated that SAAG has a sensitivity of 92.3% and specificity of 88.1%, with a diagnostic accuracy of 90.2%. In contrast, AFTP showed lower sensitivity (78.4%), specificity (65.2%), and accuracy (72.5%), indicating its inferiority as a primary diagnostic method for ascitic fluid classification.

Similar findings were reported in multiple studies. Sastry et al.6 reported SAAG' s sensitivity at 97% and specificity at 85%, with an accuracy of 96%, while AFTP had a sensitivity of 78.5% and specificity of 66%. Gupta et al. [7] found SAAG to be 95.5% sensitive and 100% specific, whereas AFTP' s

accuracy was significantly lower. The study by Suman et al.8 confirmed that SAAG is more specific (90%) than AFTP (50%), reinforcing the findings of the current research. Additionally, Khan et al. 9and Gomaa et al. 10 reported high sensitivity (96.7%) and specificity (100%) for SAAG, with AFTP performing slightly lower.

Correlation Between SAAG and AFTP

The current study found a moderate negative correlation ($r = -0.45$, $p = 0.001$) between SAAG and AFTP, meaning as SAAG increases, AFTP tends to decrease. Additionally, serum albumin showed an inverse relationship with SAAG ($r = -0.52$, $p < 0.001$) and a positive correlation with AFTP ($r = 0.48$, $p < 0.001$).

This finding is supported by Kansal et al.[11], who reported that SAAG was significantly associated with liver disease ($p = 0.0341$), while AFTP had a weaker association ($p = 0.49$). Similarly, Mandala et al. 12 observed a negative correlation between SAAG and AFTP ($r = -0.52$, $p < 0.001$), reinforcing the inverse relationship.

Additionally, Younas et al. [28] reported similar trends, confirming SAAG' s superior diagnostic power.

Distribution of SAAG and AFTP Across Different Causes of Ascites

The present study classified ascitic fluid based on SAAG and AFTP values, revealing that cirrhosis had the highest SAAG (1.6 ± 0.3 g/dL) and lowest AFTP (1.9 ± 0.5 g/dL), whereas tuberculous peritonitis (SAAG: 0.8 ± 0.2 g/dL, AFTP: 4.0 ± 0.8 g/dL) and malignant ascites (SAAG: 0.9 ± 0.2 g/dL, AFTP: 4.5 ± 0.7 g/dL) showed lower SAAG and higher AFTP values.

Comparable results were reported by Nakhale et al. [13], where cirrhosis-related ascites had a mean SAAG of 2.05 ± 0.52 g/dL and AFTP of 1.77 ± 0.73 g/dL, while non-portal hypertension ascites had SAAG values of 0.72 ± 0.19 g/dL and AFTP of 3.01 ± 0.37 g/dL. Another study by Tai-yong et al. 14 observed similar trends.

Conclusion

This study reinforces the clinical advantage of serum-ascitic albumin gradient (SAAG) over ascitic fluid total protein (AFTP) in distinguishing between exudative and transudative ascites is supported by this study. SAAG outperformed AFTP in terms of sensitivity (92.3%), specificity (88.1%), and total diagnostic accuracy (90.2%) among 104 patients. According to the results, a SAAG threshold of 1.1 g/dL is sufficient to differentiate between exudative ascites, which is more frequently seen in cancer and tuberculosis, and transudative ascites, which is mostly linked to cirrhosis and cardiac disorders.

Strong relationships between SAAG, systemic albumin levels, and indicators of liver damage provide additional biochemical evidence that SAAG is a valid predictor of ascites associated with portal hypertension. Although AFTP was helpful in detecting protein-rich exudative ascites, it was less successful in distinguishing transudative ascites and had a lower diagnostic precision.

SAAG should continue to be the gold standard for ascites distinction in clinical settings due to its exceptional performance. Despite being instructive, AFTP need to be regarded as an additional test rather than the main diagnostic standard.

Future research should explore refinements in ascitic fluid analysis and assess the role of additional biomarkers in improving diagnostic accuracy.

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