

ORIGINAL ARTICLE

Evaluation of CD68 and MCP1 in Patients with Bacterial Prostatitis

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ABSTRACT

Key words:**Prostatitis, CD68, MCP-1, PSA, CRP*****Corresponding Author:**

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Background: Bacterial prostatitis is a medical condition that affects the prostate gland. It is considered one of the most common urinary tract infections in males. There are two types of this condition: acute and chronic. Both types present with urinary symptoms and pelvic pain, but they differ in severity and duration. CD68 is a marker on the surface of macrophages that significantly contributes to immune response recognition, while MCP-1 chemokine attracts monocytes to the site of inflammation. The elevated levels of both immunological biomarkers in the blood, along with other inflammatory markers that are widely linked to the immune response. **Aim of Study:** This study investigates the evaluation of immune and inflammatory markers in patients with bacterial prostatitis. **Methodology:** A case-control study was conducted at a private clinic in Karbala and at Al-Nassiriya Teaching Hospital in Al-Nassiriya city from October 2024 to May 2025. The study involved 120 male participants, divided into three groups: Eighty patients diagnosed with acute and chronic bacterial prostatitis, and forty healthy men with no prior history of prostate infections. The participants' ages ranged from 34 to 74 years; all men were diagnosed by a urologist based on patient history and NIH criteria. MCP-1 and CD68 have been measured in men by the ELISA technique. **Results:** Patients with ABP and CBP exhibited significantly higher levels of WBC, CRP, and PSA compared to the control group ($p < 0.01$). Immune markers CD68 and MCP-1 were effective in distinguishing between ABP and CBP infections ($p < 0.01$). ROC analysis showed that, in ABP, MCP-1 had the highest diagnostic accuracy with an AUC: 99.375%, followed by CD68 (AUC: 99.063%) and PSA (AUC: 96.906%). In CBP, MCP-1 also demonstrated superior performance (AUC: 99.219%), outperforming CD68 and PSA (AUCs: 92.906% and 95.094%, respectively). **Conclusion:** In both acute and chronic prostatitis, significantly elevated levels of MCP-1 and CD68 were observed, clearly reflecting the presence of inflammatory activity in prostate tissue. Furthermore, both MCP-1 and CD68 demonstrated high sensitivity and specificity compared to PSA, thereby enhancing their diagnostic accuracy.

INTRODUCTION

Prostatitis is one of the most prevalent clinical conditions, characterized by a range of urinary symptoms such as urgency, frequency, pelvic pain, and sexual dysfunction¹. Prostatitis includes acute bacterial prostatitis (ABP), chronic bacterial prostatitis (CBP), chronic prostatitis/chronic pelvic pain syndrome (CP/CPPS), and asymptomatic inflammatory prostatitis². ABP often progresses to a chronic form, characterized by recurrent episodes interspersed with asymptomatic periods of varying duration³. The primary cause of prostate inflammation is the presence of pathogenic microorganisms. Bacterial prostatitis is frequently associated with infections caused by Enterobacteriaceae species, particularly *Escherichia coli*, as well as other well-known uropathogens⁴.

Cluster of Differentiation 68 (CD68) is a transmembrane glycoprotein that belongs to the lysosome-associated membrane glycoprotein (LAMP) family, with a molecular weight of approximately 110 kDa. It is highly glycosylated and predominantly expressed on human monocytes, macrophages, and microglia. Initially identified as a macrophage surface marker, CD68 plays a vital role in the immune response, especially in macrophage interactions with low-density lipoproteins (LDL), and is involved in immune regulation⁵. Macrophages serve both immunological and physiological functions. In response to tissue injury or infection, monocyte-derived macrophages are recruited from the bloodstream. These macrophages exhibit plasticity, adapting to environmental signals, as described in the conventional paradigm^{6,7}.

Monocyte Chemoattractant Protein-1 (MCP-1) is a key cytokine that regulates inflammatory and immune responses. It is secreted by monocytes, endothelial cells, smooth muscle cells, and fibroblasts in response to inflammatory mediators such as IL-1 and TNF- α . Moreover, bacterial infections may trigger circulating Toll-like receptor ligands, leading to increased MCP-1 production by mesenchymal stem cells in the bone marrow, thereby enhancing the innate immune response. MCP-1 binds to CCR2, which is essential for maintaining monocyte homeostasis in the bloodstream even in the absence of inflammation. It also facilitates the migration of inflammatory monocytes from the bone marrow into the bloodstream and subsequently to sites of infection^{8,9,10}.

METHODOLOGY

A case-control study was carried out in a private clinic in Karbala and at Al-Nassiriya Teaching Hospital in Al-Nassiriya city from October 2024 to May 2025. There were 120 subjects in the study. Male participants were divided into three groups Acute Bacterial Prostatitis (ABP), Chronic Bacterial Prostatitis (CBP), and controls, with forty participants in each group. The diagnosis of ABP and CBP was made according to the National Institutes of Health (NIH). The ages ranged between (34 - 74 years), Mean $\pm$ SD (53.64 $\pm$ 10.60 years). Gentile urine examination 2 (G.U.E.2) was collected after a prostatic massage done by a physician. The urine samples were processed immediately after collection and examined under 10x and 40 magnification of the field microscope to detect pus cells. A sample of blood was centrifuged to obtain serum for the measurement of PSA and CRP levels. The

sandwich ELISA was used to evaluate the biomarker MCP-1 and CD68 in blood.

Statistical analysis

Statistical analysis was carried out by IBM SPSS Statistics software version 23. Additionally, the mean and standard deviation were calculated, ANOVA and Kruskal-Wallis tests have been utilized to discern statistically significant differences across multiple groups. Receiver operating characteristic (ROC) was plotted, and cut-off, area under the curve (AUC), sensitivity (%), and specificity (%). Accuracy is indicated determined with a P value < 0.01.

RESULTS

The results of the current study showed Mean $\pm$ SD of WBCs in blood in the control, ABP, and CBP groups were $\pm$ 7.87 $\pm$ 0.79, 10.04 $\pm$ 1.32, and 9.55 $\pm$ 1.72, respectively. The Mean $\pm$ SD of pus cells in the control group was 0.00 $\pm$ 0.00, while in the ABP and CBP groups, it was 37.00 $\pm$ 8.53 and 30.00 $\pm$ 9.60, respectively. The CRP Mean $\pm$ SD in the control group was 0.72 $\pm$ 2.82, whereas in the ABP and CBP groups, it was 23.12 $\pm$ 3.62 and 17.62 $\pm$ 3.08, respectively. with a highly statistically significant P < 0.01.

MCP-1 level in serum showed a significant increase in the ABP group, with a mean $\pm$ sd of 338.38 $\pm$ 38.88, compared to the control group 68.18 $\pm$ 9.82, and the CBP group, 302.56 $\pm$ 50.28, p-value <0.01. CD68 level also showed higher in ABP group 78.55 $\pm$ 8.10 compared to the CBP 66.29 $\pm$ 12.06, and the control group (30.49 $\pm$ 4.86) with p-value <0.01. PSA levels were lowest in the control group, 2.82 $\pm$ 0.72, and highest in the ABP, 23.12 $\pm$ 3.62, compared to the CBP 17.62 $\pm$ 3.08, with a p-value of 0.00003.

Table 1: Comparison between Inflammatory and hematology parameters in patients, stratified by their control

Parameters	Control		ABP		CBP		P. value
	Mean	Std $\pm$ Deviation	Mean	Std $\pm$ Deviation	Mean	Std $\pm$ Deviation	
Blood WBCs (cells/ μ L)	7.87	0.79	10.04	1.32	9.55	1.72	0.00006**
Pus in urine (cells/HPF)	0.00	0.00	37.00	8.53	30.00	9.60	0.00002**
CRP (mg/L)	2.82	0.72	23.12	3.62	17.62	3.08	0.00003**

Blood WBCs (white blood cell), CRP (C-reactive protein), ABP (Acute bacterial prostatitis), CBP (Chronic bacterial prostatitis).

** The mean difference is significant at the 0.01 level

Table 2: Comparison between Immunological parameters in patients, stratified by their controls

Parameters	Control		ABP		CBP		P. value
	Mean	Std $\pm$ Deviation	Mean	Std $\pm$ Deviation	Mean	Std $\pm$ Deviation	
MCP1(pg/dL)	68.18	9.82	338.83	38.88	302.56	50.28	0.00003**
CD68(pg/dL)	30.49	4.86	78.55	8.10	66.29	12.06	0.00004**
PSA(ng/mL)	2.82	0.72	23.12	3.62	17.62	3.08	0.00007**

MCP-1 (Monocyte chemotactic protein -1), CD68 (Cluster of Differentiation 68), PSA (Prostate Specific Antigen)

** The mean difference is significant at the 0.01 level

In both acute and chronic bacterial prostatitis, significant positive correlations were observed between markers, blood WBCs, MCP-1, and CD68 ($R=0.649$, 0.717), respectively, with a p -value < 0.01 . Also, PSA showed a strong correlation with MCP-1 and CD68 ($R=0.811$, 0.804), respectively, with p -value < 0.01 . Furthermore, pus in urine with MCP-1 and CD68 ($R=0.839$, 0.779), respectively, p -value < 0.01 . Additionally, significant correlation between MCP-1 and CD68 ($R=0.846$ with p -value 0.00).

ROC curve in ABP visualizes the trade-off between true positive rate (sensitivity) and false positive rate.

The overall AUC, sensitivity, and specificity for PSA, MCP-1, and CD68 were as follows: (92.000%, 95.000%, 95.094%), (99.000%, 100.000%, 99.219%), (92.000%, 95.000%, 92.906%), respectively, indicating excellent diagnostic ability. As in Figure 1.

The ROC curve in CBP visualizes the trade-off between true positive rate (sensitivity) and false positive rate. The overall AUC, sensitivity, and specificity for PSA, MCP-1, and CD68 were as follows: (92.000%, 95.000%, 95.094%), (99.000%, 100.000%, 99.219%), (92.000%, 95.000%, 92.906%), respectively, indicating excellent diagnostic ability.

Table 3: Patients Correlation Coefficient Among Research Parameters According to the patients (Acute and Chronic bacterial prostatitis)

Parameters	Value	CRP	PSA	Pus in Urine	MCP1	CD68	Age
Blood WBCs	R. value	.709**	.799**	.737**	.649**	.717**	.083
	P. value	.000	.000	.000	.000	.000	.466
CRP	R. value	1.000	.866**	.855**	.811**	.804**	-.419**
	P. value		.000	.000	.000	.000	.000
PSA	R. value		1.000	.849**	.767**	.788**	-.185
	P. value			.000	.000	.000	.101
Pus in Urine	R. value			1.000	.830**	.779**	-.132
	P. value				.000	.000	.242
MCP1	R. value				1.000	.846**	-.330**
	P. value					.000	.003
CD68	R. value					1.000	-.272*
	P. value						.014

** Significant correlation at the 0.01 level.

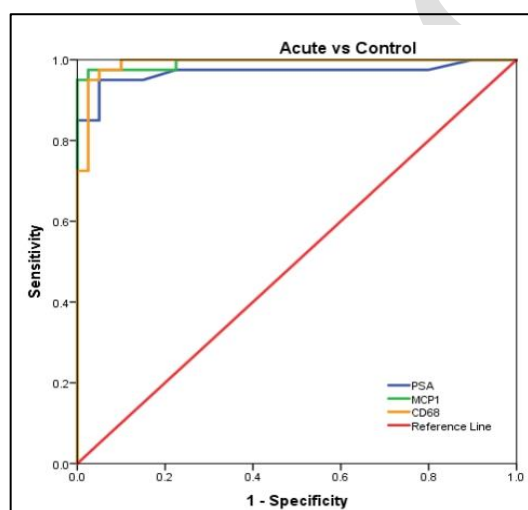


Fig. 1: A Receiver Operating Characteristic (ROC) curve was applied as a graphical diagram to show the accuracy of a binary classification model across all possible classification thresholds.

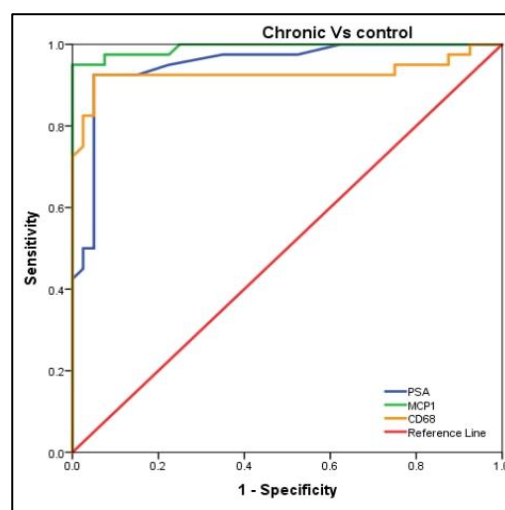


Fig. 2: A Receiver Operating Characteristic (ROC) curve was used to illustrate the performance of a binary classification model across all possible classification thresholds.

DISCUSSION

The occurrence of acute and chronic bacterial prostatitis leads to an increase in the number of white blood cells in both acute and chronic infections. Also, the number of white blood cells (WBC) increases during prostatitis as a result of the immune response triggered by bacteria in the prostate.^{11,12}

An increase in the number of pus cells in the urine above the normal limit is a sign of an immune response, where innate immune factors play a role in the appearance of symptoms.¹³ However, it can be observed that a large number of these cells may not appear in some cases, such as in cases of acute and chronic prostatitis infections, possibly because the infection does not occur in the deep tissues.¹⁴

Acute prostatitis is associated with a significant increase in CRP levels, indicating an acute inflammatory response, compared to control and chronic, indicating a rapid inflammatory response.^{15,16} Reported that both acute and chronic bacterial prostatitis lead to elevated prostate-specific antigen (PSA) levels. This increase results from inflammation and tissue damage within the prostate, which facilitates PSA leakage into the bloodstream.^{17,18} The immune response during inflammation, including increased CD68 expression, contributes to tissue remodeling and may result in prostate enlargement, accompanied by symptoms such as frequent and painful urination.¹⁹ During acute bacterial infections, macrophages detect pathogen-associated molecular patterns (PAMPs) and endogenous danger signals through pattern recognition receptors (PRRs). This triggers the activation of M1-like macrophages and the release of proinflammatory mediators.²⁰ In this study, bacterial infections significantly increased blood CD68 levels ($p < 0.01$), supporting the finding that both acute and chronic prostatitis are associated with higher CD68 expression compared to healthy controls.²¹ Monocyte Chemoattractant Protein-1 (MCP-1) levels were significantly elevated in patients with acute bacterial prostatitis compared to both chronic cases and healthy controls.²² MCP-1 levels rise during bacterial infections and remain elevated in chronic conditions, indicating ongoing immune activity.²³ Inflammation of the prostate stimulates MCP-1 expression, and its release from stromal cells increases in chronic inflammation, contributing to the development of benign prostatic hyperplasia (BPH).²⁴ The present study demonstrated that bacterial infection-induced elevations in MCP-1 and WBC levels signify a robust immune response. MCP-1 plays a central role in recruiting monocytes to the site of infection, and its elevated levels in blood reflect systemic inflammation.^{25,26}

A strong and statistically significant correlation was observed between C-reactive protein (CRP) and MCP-1 ($p < 0.01$), aligning with previous studies that reported a

similar association during inflammatory responses.^{27,28} The correlation between CRP and CD68 was also highly significant ($p < 0.05$), in agreement with prior research suggesting that elevated CRP levels enhance macrophage polarization (CD68), promoting an M1 proinflammatory phenotype.^{29,30}

There was a strong correlation between PSA and MCP-1 ($R = 0.767$), indicating that increased MCP-1 levels are associated with elevated PSA, likely due to inflammation-induced disruption of prostatic tissue barriers.³¹ Furthermore, PSA levels also correlated significantly with CD68 expression ($p < 0.05$), suggesting that increased PSA may contribute to heightened macrophage activity in the bloodstream.³²

A particularly strong correlation ($R = 0.846$, $p < 0.01$) was observed between the immunological markers MCP-1 and CD68. Both markers increase in response to inflammation, and MCP-1 may enhance the activity of CD68-positive macrophages. MCP-1 levels are further influenced by macrophage polarization during inflammatory processes, reinforcing the close relationship between these two markers.^{33,34,35}

Receiver Operating Characteristic (ROC) curve analysis confirmed the diagnostic accuracy and specificity of the immunological markers. While PSA was useful for identifying prostatic infection in both ABP and CBP, its diagnostic accuracy was limited due to overlapping elevations across various prostatic disorders. In contrast, MCP-1 showed high sensitivity and specificity in diagnosing bacterial prostatitis.³⁵ This finding supports the conclusion that MCP-1 is a reliable biomarker for identifying bacterial infections.^{36,37} Similarly, CD68 demonstrated notable diagnostic accuracy and sensitivity in both acute and chronic conditions.

CONCLUSION

In both acute and chronic prostatitis, significantly elevated levels of MCP-1 and CD68 were observed, clearly reflecting the presence of inflammatory activity in prostate tissue. Furthermore, both MCP-1 and CD68 demonstrated high sensitivity and specificity compared to PSA, thereby enhancing their diagnostic accuracy.

Ethical approval and consent of patients: This study was approved by the ethics committee of the Department of Clinical Laboratories/College of Applied Medical Sciences/University of Kerbala. Reference No: CLAMSKU/13. After the Ministry of Health and Environment granted permission to conduct the study, samples were collected, and the study started. The study participants gave their permission to collect socio-demographic data as well as undertake experiments on the selected samples with respect for patient confidentiality.

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