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Phenotypic study of bacteria isolated from patients with prostatitis

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Abstract:

Prostatitis is one of the most common conditions presented to urologists. Prostatitis is divided clinically into acute bacterial prostatitis, chronic prostatitis, chronic pelvic pain syndrome, and asymptomatic prostatitis. The acute variant is characterized by a rapid or abrupt onset of infection and leads to fever, pelvic pain, difficulty emptying the bladder, and pain in the penis, testicles, or between the scrotum and anus. In very severe cases, it may cause sepsis. The chronic variant has a symptom-based basis and is defined by persistent or recurrent manifestations of infection. Recurrent urinary tract infections, transurethral catheterization of the bladder, anatomical or functional abnormalities of the urinary tract, and systemic diseases are the primary factors contributing to the transmission of microorganisms and the development of bacterial prostatitis. Among 80 patients with acute and chronic prostatitis, the results showed that E. coli (35.0%) was the most isolated, followed by Staphylococcus aureus (17.0%), Enterococcus faecalis (17.0%), Klebsiella, and Pseudomonas aeruginosa (7.50%), respectively, while other species, such as Proteus and Enterobacter cloacae, were less common.

Keywords: Prostatitis, Acute bacterial prostatitis, Chronic bacterial prostatitis, Type of bacteria.

Introduction :

Prostatitis is a highly intricate and fundamental pathological state related to the health of the prostate gland. The occurrence of prostatitis is relatively frequent, from 2.2 to 9.7%, depending on the region of the world (Davis and Silberman, 2017). The National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), which is part of the National Institutes of Health (NIH), developed a classification related to prostatitis (Wagenlehner et al., 2013).

Bacteria in the prostate can broadly be classified as acute bacterial prostatitis, corresponding to acute-onset prostate bacterial infection. Alternatively, if the infection stays for at least 3 months,

resulting from a long-term disease, it is considered chronic, which is a nonbacterial or bacterial infection. Any nonpathogenic bacterium can cause prostatitis. It results from an ascending infection by bacteria into the prostate tissue, from an injection process through a biopsy by the needles inserted, or hematogenous, in addition to sexual (Magri et al., 2028; Nickel, 2027). In bacterial prostatitis forms, up to 80% of cases involve some Gram-negative uropathogenic *E. coli* (*UPEC*), and others are Gram-positive *E. faecalis*. The most common clinical symptoms include urinary frequency and urgency, lower back pain, joint or muscle pain, swelling or tenderness in the prostate area, fever, and painful ejaculation. These are symptoms of bacterial prostatitis, which can mimic those of other infections and conditions affecting the prostate (Lupo et al., 2020; Smieš, 2020; Abbood and Hateet, 2025).

In addition, it is characterized by its production of pigments that cause blood poisoning and pyoverdin pigment. Most *P. aeruginosa* have a capsule that protects it from phagocytosis and other virulence factors that are closely related to its high resistance to antibiotics and its tolerance to unfavorable conditions and its ability to form biofilms. The difficulty of treating hospital-acquired *Pseudomonas aeruginosa* infections is due to the emergence of multidrug-resistant strains (Salimi and Eftekhar, 2014). These strains are a major problem worldwide and are the result of the misuse of antibiotics without restrictions (Mitiku et al., 2014). The danger of infection with *P. aeruginosa* is attributed to its ability to acquire genetic traits that resist many antibiotics. Pyocyanin is a type of pigment produced by *P. aeruginosa* bacteria, derived from phenazine, which has a blue-green color. Its chemical structure is (Methyle-1hydroxyphenazine) (Abdulrazzaq and Ali, 2025).

It usually destroys the respiratory tract of humans, and its secondary metabolite, which is soluble in water, appears. It has antimicrobial activity against a variety of microorganisms. The microbial effect also works as a broad and lethal antimicrobial in nature (Chieda et al., 2011). Laboratory studies have indicated that PCN interferes with multiple cellular functions, including its importance during clinical infection is uncertain, due to the difficulty of determining the contribution of PCN from many virulence factors produced by *P. aeruginosa* bacteria during infection, in addition to a few cellular pathways affected (Lau et al., 2014). It is characterized by being a metabolite Multi-functional through its role in cellular respiration, induction of programmed cell death, and damage to the human body (Ochoa et al., 2015). It can act as an antimicrobial by inhibiting the growth of several types of bacteria and fungi. The study aimed to shed light on this type of bacteria and investigate some patterns belonging to the same type. And to identify the virulence factors as they are among the types that pose a danger in the medical aspect due to their high resistance to antibiotics and have high virulence factors. Therefore, the aim of study was isolated bacteria from patients with prostatitis.

Materials and Methods:

Case-control study, carried out in a private clinic in *Karbala* and at *Al-Nassiriya Teaching Hospital* from October 2024 to May 2025. 120 subjects in the study; the first group, consisting of 40 men with ABP, the second group included 40 patients with CBP, and the third group consisted of 40 healthy men with no previous history of prostate infection. The ages ranged between (34 - 74

years), and the BMI mean ± SD was (28.93 ± 2.65). Specimens were taken from patients and healthy controls, including a urine sample, before and after prostatic massage. Urine samples are diagnosed by microscopic examination and inoculation on standard culture media, including MacConkey, Blood agar, and identification of bacteria by using the VITEK**-2** system**.** The present study strictly followed the criteria for including patients who were diagnosed with bacterial prostatitis (BP), who were assessed by a urologist.

Statically Analysis:

Statistical analysis utilizing was IBM SPSS Statistics version (23). The analysis results were consolidated using descriptive statistics. A probability criterion of $p < 0.05$ was used to evaluate the observed data for statistical significance. The categorical variables were analyzed using the chi-square test.

Result:

The participants' ages ranged from 34 to 74 years, with an average age of 53.64 ± 10.60 years. A value of 0.00004 for overall age indicates a very significant difference between the groups under and over 50 years. The average and standard deviation of ABP and CBP in the control and patient groups under 50 years old were 42.47 ± 4.56 and 42.22 ± 3.70, respectively (p-value>0.05). The mean ± SD for ABP and CBP in the control and patient groups under 50 years was 59.96 ± 5.54, 56.38 ± 5.32, and 62.48 ± 6.21, respectively, with a significant p-value >0.05. The p-value of 0.00004 for total age indicates a statistically significant difference between the groups. Body Mass Index (BMI), patients were divided into two groups: overweight and obese. The mean of BMI in the control group was (28.92 ± 2.48), while in acute bacterial prostatitis it was (28.82 ± 3.08), and in chronic bacterial prostatitis it was (29.07 ± 2.41), with a non-significant P-value >0.05

Table 1: Distribution and Characteristics of Patients and Controls According to BMI and Age

Parameters	Groups	Control	Acute	Chronic	Total	P. value
BMI Group	Overweight	23 57.5%	26 65.0%	22 55.0%	71 59.2%	0.63865 NS
	Obese	17 42.5%	14 35.0%	18 45.0%	49 40.8%	
Age Group	Less than 50	15 37.5%	32 80.0%	0 0.0%	47 39.2%	0.00002**
	Greater than 50	25 62.5%	8 20.0%	40 100.0%	73 60.8%	
Age (Mean ± Std. Deviation)	Less than 50 (Mean ± Std. Deviation)	42.47 ± 4.56	42.22 ± 3.70	N/A	N/A	0.84358 NS
	Greater than 50 (Mean ± Std. Deviation)	59.96 ± 5.54	56.38 ± 5.32	62.48 ± 6.21	60.94 ± 6.15	0.02090*
	Overall age (Mean ± Std. Deviation)	53.40 ± 10.00	45.05 ± 6.99	62.475 ± 6.21	53.64 ± 10.60	0.00004**
BMI (Mean ± Std. Deviation)		28.92 ± 2.48	28.82 ± 3.08	29.07 ± 2.41	28.93 ± 2.65	0.91462 NS

* Association is significant at the 0.05 level..
** Association is significant at the 0.01 level.
Ns Association is non-significant at the 0.05 level.

The control group showed negative cultures. Regarding acute bacterial prostatitis, bacterial isolation in the patient group revealed that *E. coli* accounted for 35% of the bacterial species most frequently isolated, followed by *Staphylococcus aureus* and *Enterococcus faecalis,* each of which was 17.5%, *Klebsiella*, and *Pseudomonas aeruginosa* (6%). The organisms *Proteus* and *Enterobacter cloacae* had the lowest percentages, with 4% and 2%, respectively. With a non-significant value >0.05. The results also showed statistically significant differences of 0.02854 and 0.00184, respectively, between the different types of bacteria in acute and chronic infections, with p-values < 0.01.

In ABP, E. coli and Enterococcus faecalis are the most common bacterial types (p-value < 0.05).

E. *coli*, *Enterococcus faecalis, and Staphylococcus aureus* are more prevalent in CBP, with a p-value <0.01.

Table 2. Patients' Distribution and Characteristics of Bacterial Types According to the Age Groups

Type of bacteria	Acute	Chronic	Total	P. value
E. coli	14 35.00%	14 35.00%	28 35.00%	
Enterococcus faecalis	8 20.00%	9 22.50%	17 21.30%	
Staphylococcus aureus	7 17.50%	10 25.00%	17 21.30%	
Klebsiella pneumoniae	4 10.00%	2 5.00%	6 7.50%	0.29792 NS
Pseudomonas aeruginosa	3 7.50%	3 7.50%	6 7.50%	
Proteus	0 0.00%	2 5.00%	2 2.50%	
Enterobacter cloacae	4 10.00%	0 0.00%	4 5.00%	
P. value	0.02854*	0.00184**	0.00017**	

* Association is significant at the 0.05 level..
** Association is significant at the 0.01 level.
Ns Association is non-significant at the 0.05 level.

The results in Table 3 show the distribution of bacterial types among patients according to age groups (less than 50 and greater than 50). It showed that E. coli had similar percentages across both age groups, with a total of 35.00%. Enterococcus faecalis was more prevalent in individuals over 50, with a percentage of 27.10%. Enterobacter cloacae was found in patients under 50 at a

rate of 12.50%. and Staphylococcus aureus. As for the other bacterial types, Klebsiella pneumoniae was more common in individuals under 50, with a percentage of 21.90%. P-value >0.05

Table 3. Patients' Distribution and Characteristics of Bacterial Types according to the BMI groups

Type of bacteria	Less than 50	Greater than 50	Total	P. value
E. coli	11	17	28	
	34.40%	35.40%	35.00%	
Enterococcus faecalis	4	13	17	
	12.50%	27.10%	21.30%	
Staphylococcus aureus	7	10	17	
	21.90%	20.80%	21.30%	
Klebsiella pneumoniae	3	3	6	0.29792 NS
	9.40%	6.30%	7.50%	
Pseudomonas aeruginosa	3	3	6	
	9.40%	6.30%	7.50%	
Proteus	0	2	2	
	0.00%	4.20%	2.50%	
Enterobacter cloacae	4	0	4	
	12.50%	0.00%	5.00%	
P. value	**0.09950 NS**	**0.00017****	**0.00017****	

* Association is significant at the 0.05 level..

** Association is significant at the 0.01 level.

Ns Association is non-significant at the 0.05 level.

A total of seven bacterial species were isolated from overweight and obese people. *E. coli* is the most commonly discovered in both groups (35%). The prevalence *of Enterococcus faecalis* was 20.80% in the overweight group and (21.90%) in the obese group. Staphylococcus aureus was found in (22.90%) and (18.805) of the samples, while *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Proteus,* and *Enterobacter cloacae* were less prevalent. Overall, there was no significant association between bacterial species distribution and BMI.

Table 4. Bacterial Types according to their weight and Obses

Type of bacteria	Overweight	Obese	Total	P. value
E. coli	16	12	28	
	33.30%	37.50%	35.00%	
Enterococcus faecalis	10	7	17	
	20.80%	21.90%	21.30%	
Staphylococcus aureus	11	6	17	
	22.90%	18.80%	21.30%	
Klebsiella pneumoniae	4	2	6	
	8.30%	6.30%	7.50%	0.98234 NS
Pseudomonas aeruginosa	3	3	6	
	6.30%	9.40%	7.50%	
Proteus	1	1	2	
	2.10%	3.10%	2.50%	
Enterobacter cloacae	3	1	4	
	6.30%	3.10%	5.00%	
P. value	**0.00017****	**0.00157****	**0.00017****	

* Association is significant at the 0.05 level..

** Association is significant at the 0.01 level.

Ns Association is non-significant at the 0.05 level.

Discussion:

Prostatitis is characterized as acute bacterial prostatitis, chronic bacterial prostatitis, chronic inflammatory and non-inflammatory prostatitis, or chronic pelvic pain syndrome, and silent inflammatory prostatitis. Prostate inflammation is a prevalent syndrome in males (Zorman et al., 2015). The *E. coli and Enterococcus faecalis* are common types in CBP, while the rates for other bacterial species, such as *Pseudomonas aeruginosa, Staphylococcus aureus, and Staphylococcus haemolyticus*, were lower. In ABP, bacterial growth occurred in 86.7% of cases with acute infection, with *E.coli* being the most common, followed by *Klebsiella spp*, while other species appeared less frequently (Arda et al., 2018; Addis et al., 2021).

E. coli was the most frequent percentage of 87.5% cause of both acute and chronic prostatitis. Also discovered was *Staphylococcus aureus*. This suggests that these two bacteria still cause a significant portion of clinical cases of prostatitis. Additional bacterial species found include *Pseudomonas aeruginosa, Klebsiella pneumoniae, Proteus mirabilis, and Enterococcus faecalis* (Ramakrishnan and Salinas, 2010). Research indicates that the formation of bacterial biofilms is a main factor in the recurrence of infections and the dissemination of bacterial species such as *E. coli*, *Staphylococcus aureus*, and *Enterococcus spp.* The formation of this biofilm enhances bacterial resistance to treatments, facilitating their dissemination and causing infections in the tissues of the prostate (Zhao et al., 2023; Addis et al., 2021).

Acute prostatitis is more frequent in males under 50, especially young to middle-aged individuals, who make up the large majority of acute cases. On the other hand, males between the ages of 50 and 59 are more likely to get chronic prostatitis. The chance of getting a chronic infection is three times higher in the oldest than in younger men (Kanani et al., 2021). The ageing process affects the immune system, resulting in a complicated phenomenon termed immunosenescence. The primary processes include alterations in immune cell composition, functional deficiencies of immune cells, deregulation of immunological signaling pathways, and persistent inflammation. This results in a notable deterioration of immunological function, increasing an individual's vulnerability to various diseases (Vipula, 2025; Kanani et al., 2021).

E.coli infections were more common in younger patients, particularly those aged 50-69 and ≤50. *Klebsiella pneumoniae* and *Pseudomonas aeruginosa* had no significant association with age because there was no clear distribution pattern across different age groups, whereas *Enterococcus faecalis* can cause urinary tract infections (UTIs), especially in elderly men who have received frequent or prolonged antibiotic treatments, which can lead to an overgrowth of these bacteria. *Staphylococcus aureus*, while less common, can cause UTIs in elderly men, especially those who have immunocompromised conditions or long-term urinary catheters. The incidence rises with age, starting at 0.05 per person per year in men and increasing to 0.08 per person per year in men aged 85 and up (Zhan et al., 2024; Kim and Lee, 2023).

Enterobacter cloacae affect men, seen across all age groups. Notably, the impact was greatest in the 40-50 age range, with a 17.76% higher incidence rate than in other age groups. Another study discovered that people under the age of 50 were more susceptible than older people (Assouma et al., 2023). The overweight and obese categories are associated with prostatitis. However, our results showed no statistically significant difference between those with acute and chronic prostatitis, suggesting that other factors could affect inflammation and affect BMI (AlDhaheri et al., 2020).

Central obesity refers to the accumulation of adipose tissue surrounding essential organs. The measurement is conducted using the waist-to-hip ratio (WHR). Central obesity has been shown to correlate with inflammation in prostate tissue, perhaps resulting in the emergence of lower urinary tract symptoms LUTS (Fowke et al., 2016). Patients with a higher body mass index had a more noticeable inflammatory process and prostate dysfunction (Amelchenko and Vinnik, 2024). Men's body composition changes with age. Testosterone levels naturally decrease with age. These hormonal changes have a significant impact on body composition, particularly fat accumulation and redistribution to central locations (visceral fat), contributing to an increase in body mass index (BMI). This is significant because visceral adiposity is associated with insulin resistance and increased levels of pro-inflammatory cytokines. These metabolic changes have a significant impact on prostate function (Welén and Damber, 2022).

Conclusion:

The results showed that *E. coli* bacteria were the most common cause of both acute and chronic bacterial prostatitis infections, while other types contributed to the infections at varying

rates. Age also showed an impact on the incidence of prostatitis, which increases with aging and increased exposure to health problems related to the urinary system. Additionally, obesity was a contributing factor to the increased incidence of infections.

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Declaration of Competing Interest:

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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