The relationship of ABO and Lewis blood groups in patients with urinary tract infection

Abstract

Aims. Urinary tract infection considers as one the most common adult bacterial infection worldwide. Antigens of ABO and Lewis blood groups may influence bacterial adherence and lead to an increase in the frequency of UTI in adults. The aim of this study to evaluate the relationship of ABO, and Lewis blood groups with UTI. As well as to determine the main microbial cause of UTI and its association and distribution with blood group antigens.

Method. Blood sample of 80 UTI patients and 50 healthy persons used for determination of ABO and Lewis blood groups by agglutination assay. Urine samples of UTI patients were cultured and identified based on culture characteristics, gram staining and biochemical tests.

Results. Urinary tract infection was significantly highest in patients with O blood group (42.5%) Lewis (a-b-) phenotype (38.8%) as compared with other blood groups and with control group. *Escherichia coli* was found to be the commonest bacterial isolates observed in UTI patients. Also *E. coli* was significantly highest among UTI patients with O blood group and Lewis (a-b-) phenotype.

Conclusion. The study concludes that ABO and Lewis blood types as well as secretor status have a significant association with susceptibility to infection with urinary tract infection. O blood group as well as Lewis (a-b-) phenotype have a higher susceptibility to urinary tract infection. *Escherichia coli* was the main causative agent of UTI and it was statistically significantly highest in patients with O blood group and Lewis (a-b-) phenotype.

Keywords Urinary tract infection, *Escherichia coli*, ABO blood group, Lewis blood group, Secretor status.

Introduction

Urinary tract infection (UTI) is a major health issue, as it considers one of the frequent adult bacterial infections worldwide (1). Approximately 150-250 million cases a year is the range of UTI global prevalence (2). It can affect males and females of different ages, with dangerous effects including recurrent infection, kidney damage in young children and pyelonephritis with sepsis (3). It is linked to an elevated risk of maternal and neonatal illness and mortality in pregnant women (4). UTI is caused by both gram negative and gram positive bacteria in addition to some fungi, where have different virulence factors for adhesion and colonization (5). *Escherichia coli* is responsible for More than 95% of urinary tract infections, the most prevalent infecting bacterium in acute urinary tract infection (٦). There are various bacterial attachment mechanisms that play a key part in the pathophysiology of UTI (٧). Uropathogenic *E.coli* having different virulence factors that increase its ability to colonize the urogenital tract (8). Different isolates of *Klebsiella pneumonia*, *Pseudomonas aeruginosae*, *Proteus mirabilis*, *Staphylococcus aureus*, *Staphylococcus saprophyticus*, and *Pseudomonas spp.* were also obtained from UTI in different studies (9,10). The ABO blood group system identifies the many blood groups in human population, which are A, B, O, and AB, whereas the Rh factor identifies the positive and negative status of various human blood groups (11). Blood group antigens are hereditary biological markers that are present throughout one's life and play an important role in transfusion safety, genetics, inheritance pattern, and disease susceptibility (12). ABO blood group antigens are glycoproteins and glycolipids present on erythrocytes and the mucosal epithelial cells, as well as free antigens in body fluids such as saliva, blood, milk, and intestinal contents (13,14). ABO blood group has an association with another blood group known as Lewis blood group, which has three frequent phenotypes including Le(a+b-), Le(a-b+) and Le(a-b-) (15). Lewis blood antigens are found on the surfaces of erythrocytes, kidney, endothelium, genitourinary and gastrointestinal epithelium, in addition to being secreted in body fluids (16). According to secretor status, secretors whom secrete of ABO blood group antigens in the bodily fluids like saliva, sweat, tears, and serum. While non-secretors who lack these antigens in bodily fluids (17). The secretors have Le(a-b+) phenotypes, where they express ABO carbohydrates in exocrine secretions as well as red blood cells. Non-secretors have the Le (a+b-) phenotype and Lewis (a-b-), where they solely express ABO carbohydrates in erythrocytes only (18). ABO and Lewis blood group antigens have been linked to susceptibility and resistance to infections and infectious diseases in various studies. (19). Many diseases, including duodenal ulcers, urinary tract infections, and diabetes, as well as genetic disorders, are linked to antigens of ABO and Lewis blood types (12, 20). Bacterial adhesion and the occurrence of urinary tract infection can be altered by the presence of antigens of ABO blood group on the uroepithelial cells surface (21, 22). Also other study revealed the susceptibility of persons with the Lewis Le(a-b-) phenotype to the uropathogenic *Escherichia coli* strain (23). Certain studies confirmed between recurrent UTI infections and an increased incidence of chronic inflammation, with ABO non-secretors (24). The following are the

study's objectives: to study relationship of ABO and Lewis blood groups as well as secretor status with urinary tract infection. Also to determine the most common species of bacteria among UTI patients and their relation with ABO and Lewis blood groups.

Material and Methods

Patients and control

The total patients with UTI were 80, they were 50 (62.5%) females and 30 (37.5%) males with age ranges from 20 to 80 years attending AL-Sader Teaching Hospital. The specialist managing doctors diagnosed and assessed the patients based on their histories, clinical examinations, and laboratory tests. Control group consist of fifty healthy persons 29 (58%) females and 21 (42%) males. Blood samples were collected from both UTI patients and control group for the determination of ABO and Lewis blood groups. Urine samples were also collected from the patients with UTI for bacterial culture.

Methods

The ABO blood groups as well as Rh blood typing were determined by using a commercially available ABO kit that includes three types of solution antisera A, B, and Rh (D). To determine the type of ABO blood group, the tested blood reacted with either anti-A or anti-B, and anti-Rh antibodies s, and the agglutination process may be seen with the naked eye. To establish if the blood type is Rh-positive or Rh-negative, a blood drop was mixed with an anti-D solution. When a reaction occurs, the patient's blood is Rh positive; when no reaction occurs, the patient's blood is Rh negative. Also the Lewis blood phenotypes was determined by using standard agglutination technique using (anti-Le a) and (anti-Le b) according to the manufacturer's instructions (Lorne Laboratories Limited, England). First, (2-3%) erythrocyte suspension was prepared. Then the (anti-Lewis a) and (anti-Lewis b) test tubes were then identified, with a drop of each reagent in each, and the cell suspension was added to each tube and mixed. Sample was then centrifuged for 20 seconds at 1500 rpm. The sediment at the end of the tube was gently removed, and read directly under the microscope. When the test red blood cells agglutinated, it was considered a positive result and showed the presence of Lewis antigen, either Lea or Leb. But if no agglutination of the test red cells it considered a negative result which indicates the absence of Lea or Leb. Individuals with Lewis (a-b+) were classified as secretors, while those with Lewis (a+b-) and Lewis (a-b-) were classified as non-secretors. Urine samples from UTI patients were collected from midstream into sterile tubes and transported to the laboratory within 2 hours. Urine samples were then inoculated into MacConkey's agar media in addition to blood agar media using sterile loop (Merck, Germany). Plates were then aerobically incubated at 37°C for 24-48 hours. Identification was done depending on culture characteristics, gram staining and routine biochemical tests. (25, 26).

Statistical analysis

Data analysis was done by using social package statistical science (SPSS) version 20. To evaluate the data results, Chi square tests (X2) with probability (P) values were computed at the 0.05 level of significance.

Results

The frequency distribution of urinary tract infection in female patients 50 (62.5%) was higher than male patients 30 (37.5%) as compared with control group were female 29 (58%) than male 21 (42%). However, as indicated in table (1), these differences in both sexes were not significant as compared with control group. According to age group, UTI patients and control ages ranged from 20-80 years. The patients with (30-39) age group are the highest infected by UTI with a frequency of (38.8%) and the lowest frequency (10%) was among patients with (≥50) age group. As indicated in table (2), these differences were also not significant as compared with control group.

Table (1): Frequency of UTI patients and healthy controls group according to sex.

Sex	**Patients NO (%)**	**Control NO (%)**	**Total NO (%)**
Male	30 (37.5)	21 (42)	51 (39.2)
Female	50 (62.5)	29 (58)	79 (60.8)
Total	80	50	130

$X^2 = 2.61$ ($P > 0.05$)

Table (2): Frequency of UTI patients and healthy control according to age groups.

Age group	**Patients**		**Control**		**Total NO (%)**
	NO.	**(%)**	**NO.**	**(%)**	
20-29	21	(26.3)	11	(22)	32 (24.6)
30- 39	31	(38.8)	16	(32)	47 (36.2)
40-49	20	(25)	19	(38)	39 (30)
≥ 50	8	(10)	4	(8)	12 (9)
Total	80		50		130

$X^2 = 2.480$ ($P > 0.05$)

The association of ABO blood group types in UTI patients and control group shown in (table 3). Blood group O 34 (42.5%) was the most common among UTI patients, followed by B 23 (28.8%), then A 13 (16.3%), and AB 10 (12.5%). Whereas in control group, A blood group 17 (34%) was most common, then B 15 (30%), O 13 (26%), and AB 5 (10%). Urinary tract infection was significantly highest in patients with B blood group than other groups as compared with control ($p< 0.05$).

According to Rh(D) system among UTI patients comprised of Rh positive phenotype 68 (85%) and Rh negative phenotype 12 (15%) as shown in (table 4). The healthy controls comprised of Rh positive phenotype 44 (88%) and Rh negative phenotype 6 (12%), but the difference were not significant (p> 0.05).

Table (3): Association of ABO blood groups between UTI patients and control group.

ABO blood groups	Patients NO (%)	Control NO (%)	Total NO (%)
O	34 (42.5)	13 (26)	47 (36.2)
A	13 (16.3)	17 (34)	30 (23.1)
B	23 (28.8)	15 (30)	38 (29.2)
AB	10 (12.5)	5 (10)	15 (11.5)
Total	80	50	130

X^2 = 6.701 (P < 0.05)

Table (4): Association of Rh phenotypes between UTI patients and control.

Rh group	Patients NO (%)	Control NO (%)	Total NO (%)
Rh^+	68 (85)	44 (88)	112 (86.2)
Rh^-	12 (15)	6 (12)	18 (13.8)
Total	80	50	130

X^2 = 0.232 (P > 0.05)

The association of Lewis blood group phenotypes between UTI patients and control as shown in (table 5). The highest frequency of Lewis phenotype among UTI patients was Le(a-b-) 31 (38.8%), then Le (a+b-) 29 (36.3%) and lowest frequency phenotype was Le(a-b+) 20 (25.0%). While in the control group the highest frequency of Lewis phenotype was Le(a-b+) 26 (52%) and lowest frequency was (Lea+b-) 11 (22%). The urinary tract infection was significantly highest among patients with Lewis phenotype (a-b-) than other phenotypes as compared with healthy controls (p< 0.05). Regarding Lewis phenotype blood group among UTI patients, the distribution of secretor and nonsecretor phenotype between UTI patients and control was shown in table (6). The high frequency of UTI among patients with nonsecretor phenotype 60 (75%), while low frequency with secretor phenotype 2٠ (٢٥ %). In contrast with control group the secretors were 26 (52 %) while the non-secretors were 24 (48 %), and all these differences were significant (p< 0.05).

Table (5): Association of Lewis phenotypes between UTI patients and control.

Lewis blood groups	Patients NO (%)	Control NO (%)	Total NO (%)
a-b+	2٠ (2٥)	26 (52)	4٦ (3٥.٤)
a+b-	29 (36.3)	1١ (٢٢)	4٠ (3٠.٨)
a-b-	3١ (3٨.٨)	13 (26)	4٤ (3٣.٣)
Total	80	50	130

X^2 = ٩.8٤8 (P < 0.05)

Table (6): Association of secretor state in UTI patients and control.

Secretor state	Patients NO (%)	Control NO (%)	Total NO (%)
Secretor	2٠ (2٥)	26 (52)	4٦ (3٥.٤)
Non secretor	٦٠ (7٥)	24 (48)	8٤ (6٤.٦)
Total	80	50	130

X^2 = ٩.٨١١ (P < 0.05)

The most common bacterial species isolates from urine culture of UTI patients were *E. coli* (37.٥%), followed by *Klebsiella spp.* (17.٥%), *Staphylococcus saprophyticus* (15%), *Staphylococcus aureas* (13.75%), *Pseudomonas aeruginosa* (8.75%), *Streptococcus faecalis* (5.0%) and *Proteus mirabilis* (2.5%) as shown in table (7). From this table the isolates of gram negative bacteria were higher than gram positive bacteria were 53/80 (66.25%) and 27/80 (33.75%), respectively.

Table (7): The distribution of gram negative and gram positive bacteria among UTI patients.

Group of bacteria	Pathogens	Number of Isolates (%)	Total Number of Isolates (%)
gram negative bacteria	*Escherichia coli*	30 (37.٥)	53 (66.25)
	Klebsiella spp.	١4 (١7.5)	
	Pseudomonas aeruginosa	7 (8.7)	

	Proteus mirabilis	2 (2.5)	
gram positive bacteria	*Staphylococcus saprophyticus*	12 (15)	27 (33.75)
	Staphylococcus aureus	11 (13.8)	
	Streptococcus faecalis	4 (5)	
Total		80 (100)	80 (100)

The results of relation between ABO blood groups and the bacterial species isolated from UTI patients showed that O blood group phenotype have the highest bacterial isolates 34 (42.5%), followed B phenotype 23 (28.8%), A phenotype 13 (16.3%) and lowest in AB phenotype 10 (12.5%). The most common bacterial species in the patients with O blood group were *E. coli* (18.8%) followed by *Klebsiella spp.* (7.5%) and *Staphylococcus saprophyticus* (7.5%). The most common bacteria among the patients with A blood group were *E. coli* (7.5%), *Klebsiella spp.* (3.8%) and *Staphylococcus aureus* (2.5%). The most prevalent isolates among B blood group patients were *E. coli* (8.8%), *Klebsiella spp.* (6.35%), then *Staphylococcus aureus* and *Pseudomonas aeruginosa* (5%). Among the patients with AB blood group *Staphylococcus saprophyticus* have higher frequency (5%). All these differences statistically significant ($P < 0.05$) as shown in (table. 8). In general, the most common bacterial isolates are *E. coli* which are the highest among patients with O and B blood groups. Furthermore, it was showed that gram negative bacteria have highest frequency among patients with O blood group 23 (28.8%), then B blood group 17 (21.3%), and lowest among patients with AB blood group 3 (3.8%). Also gram positive bacteria have high frequency among patients with blood group O 23 (28.8%) and lowest among patients with A blood group 3 (3.8%). As indicated in table (9), where all these differences were significant ($p < 0.05$) (table 9).

Table (8): The frequencies of bacterial isolates among UTI patients according to ABO blood groups.

Bacterial species	**Total NO (%)**	**Blood groups**			
		O No (%)	**A No (%)**	**B No (%)**	**AB No (%)**
Escherichia coli	30 (37.5)	1٥ (1٨/٨)	6 (7.5)	٧ (٨/٨)	2 (2.5)
Klebsiella spp.	14 (17.5)	6 (7.5)	3 (3.8)	5 (6.3)	0 (0.0)
Staphylococcus saprophyticus	12 (15.0)	6 (7.5)	0 (0.0)	2 (2.5)	4 (5.0)
Staphylococcus aureus	11 (13.8)	3 (3.8)	2 (2.5)	4 (5.0)	2 (2.5)
Pseudomonas	7 (8.8)	2 (2.5)	1 (1.3)	4 (5.0)	0 (0.0)

aeruginosa					
Streptococcus faecalis	4 (5.0)	2 (2.5)	1 (1.3)	0 (0.0)	1 (1.3)
Proteus mirabilis	2 (2.5)	0 (0.0)	0 (0.0)	1 (1.3)	1 (1.3)
Total	80 (100)	34 (42.5)	13 16.3)	23 (28.8)	10 (12.5)

X^2 = 20.818 (P < 0.05)

Table (9): Frequencies of gram negative and gram positive bacteria among UTI patients according to ABO blood groups.

ABO blood groups	**Type of bacteria**		**Total NO (%)**
	Gram - bacteria NO (%)	**Gram + bacteria NO (%)**	
O	23 (28.8%)	11 (13.8%)	34 (42.5%)
A	10 (12.5%)	3 (3.8%)	13 (16.3%)
B	17 (21.3%)	6 (7.5%)	23 (28.8%)
AB	3 (3.8%)	7 (8.8%)	10 (12.5%)
Total	53 (66.3%)	27 (33.8%)	80

X^2=7.173 (P<0.05)

The results about relation between Lewis blood groups and the bacterial species that isolated from UTI patients summarized in table (10). In general it was found that patients with Le(a-b-) phenotype have the highest bacterial isolates 31 (38.8%), followed Le (a+b-) 29 (36.3%) and lowest in Le(a-b+) phenotype 20 (25.3%). The highest bacterial isolates among patients with Le (a-b+) phenotype were *E. coli* 9 (11.3%) followed *Klebsiella spp.* 4 (5%) and *Staphylococcus aureas* 4(5%). Also *E. coli* was the highest bacterial isolates among patients with Le (a+b-) phenotype 8 (10%), followed *Staphylococcus saprophyticus* 7(8.8%) and then *Klebsiella spp.* 5 (6.3%). Among patients with Le(a-b-) phenotype the highest frequency bacterial isolates were *E. coli* 8 (10%), followed *Klebsiella spp.* 5 (6.3%), and then *Staphylococcus saprophyticus* and *Staphylococcus aureas* where they 4 (5%). In general, the most common bacterial isolates are *E. coli* which are highest in patients with Le (a-b-) as well as Le (a+b-) phenotypes. Furthermore, gram negative bacteria have significantly highest frequency among Le (a-b-) phenotype patients 22 (27.5%), then Le (a+b-) phenotype patients 16 (26,3%) and lowest among Le(a-b+) phenotype patients 15 (20%) ($p< 0.05$). The gram positive bacteria have highest frequency among Le(a+b-) phenotype patients 13 (10%) but lowest among Le(a-b+) phenotype patients as shown in table (11).

Table (10): The frequencies of bacterial isolates among UTI patients according to Lewis blood groups.

Bacteria isolates	Total NO	La-b+ NO (%)	La+b- NO (%)	La-b- NO (%)
E.coli	30 (37.5)	9 (11.3)	8 (10)	13 (16.3)
Klebsiella spp.	14 (17.5)	4 (5)	5 (6.3)	5 (6.3)
Staphylococcus saprophyticus	12 (15)	1 (١/٣)	7 (8.8)	4 (5)
Staphylococcus aureas	11 (13.8)	4 (5)	3 (3.8)	4 (5)
Pseudomonas aeruginosa	7 (8.8)	2 (2.5)	2 (2.5)	3 (3.8)
Streptococcus faecalis	4 (5)	0 (0)	3 (3.8)	1 (1.3)
Proteus mirabilis	2 (2.5)	٠ (٠/٠)	1 (1.٣)	١ (١.٣)
Total	80 (100)	2٠ (2٥.3)	٢٩ (3٦.٣)	٣١ (3٨.٨)

X^2= ٨.٨9٨ (P<0.05)

Table (11): The frequencies of gram negative and gram positive bacteria among UTI patients according to Lewis blood groups.

Lewis blood groups	Type of bacteria		Total NO (%)
	Gram - bacteria NO (%)	Gram + bacteria NO (%)	
La-b+	15 (20)	5 (6.3)	20 (25.0)
La+b-	16 (26.3)	13 (10)	29 (36.3)
La-b-	٢٢ (2٧.5)	9 (17.5)	31 (38.8)
Total	53	27	80

X^2= 4.905 (P< 0.05)

Discussion

This study concentrates on the association of urinary tract infection with ABO and Lewis blood types because UTI considered as serious issues globally. Also highlights the most common of bacterial species related with ABO and Lewis blood types in patients with UTI. According to this study, female patients had a higher rate of UTI than male patients. Also patients with (30-39) age group are highest infected by UTI than other age groups and with control, but the difference in these results were not statistically significant. The results showed that both sexes are infected with

urinary tract infection, also this infection was distributed in all age groups. Similar results have been recorded in other studies where suggested no different among patients with urinary tract infection according to sex and age (27, 28). While other studies revealed that UTI was highest in females as compared with males and showed high ratio in old aged (>45 years) (29). The reason suggested that shorter length of the urethra makes females more prone to UTI than males (30). Results confirmed a relationship between ABO blood group and UTI. It was observed that the urinary tract infection was significantly highest ratio ($P<0.05$) in patients with blood group phenotypes O (42.5%) followed blood group B (28.8%). This lines with what was found in other studies (31-33). According to the Rh(D) system, although UTI patients have Rh positive phenotype higher than Rh negative phenotype, this difference is not significant. Differences in the ABO blood group antigen expression can promote infection by serving as receptors. The variation of ABO blood group antigens of mucosal glycans can have a role in effecting bacterial adhesion and bacteria-mucus interactions (34). Also Amjadi discovered that the carbohydrates of ABO blood antigens work as a receptor for bacteria, facilitating their entry and causing infection (35). Additionally, results showed a significantly relation of Lewis blood groups and urinary tract infection ($p<0.05$) They revealed that urinary tract infection was significantly highest in patients with Lewis (a-b-) phenotypes (38.8%), followed other Lewis blood groups phenotypes Le(a+b-) (36.3%) and Le(a-b+) (25.0%). Also the urinary tract infection was significantly highest among non-secretor patients than secretor patients. These results agree with other studies where revealed the increase of urinary tract infection among non-secretors than secretors (36,37). Sheinfeld et al. (1990) discovered that women with Lewis (a-b-) and Lewis (a+b-) blood phenotypes have threefold higher risk of recurrent UTI than Lewis (a-b+) phenotype, implying that epithelial cells in nonsecretor individuals have more receptors for bacteria and tend to have an increase in the inflammatory responses than the epithelial cells with secretors (38). Also the increased recurrent UTI susceptibility in nonsecretor has been attributed to the absence of exposed, fucosylated sugar residues on bladder and vaginal epithelial cells where the cells may not be protected from *E. coli* binding (39).

Urine culture results showed that *Escherichia coli* (37.5%) was the major bacterial isolates among UTI patients, followed by *Klebsiella* (17.5%) as compared with other bacterial isolates. The other species of bacteria were less frequent including *Staphylococcus saprophyticus*, *Staphylococcus aureas*, *Pseudomonas aeruginosa*, *Streptococcus faecalis* and *Proteus mirabilis*. Also results revealed gram negative bacteria are higher than gram positive bacteria. In general, these findings are consistent with those of other studies where showed that *E. coli* is the major etiological agent in causing urinary tract infections (40,41). The predominance of *E. coli* could be attributed to their distinctive features, such as (pili or fimbriae), which aid in their adhesion to the uroepithelium and raise infection risks. (42). In addition to other studies discovered that *E. coli* was the most common isolate causing UTI, *Klebsiella pneumonia* was next. (43). Furthermore, many studies reveal that majority of bactrial isolates in UTI infection are gram negative bacteria than gram positive bacterial

isolates (44). The most frequent gram positive bacteria isolated from UTI patients were staphylococcus saprophyticus and Staphylococcus aureus (45,46). Many studies showed the other pathogens that followed *E. coli* were (*Klebsiella pp.*, *Enterococcus faecalis*, *group B streptococci, Staphylococcus saprophyticus,* and *Proteus mirabilis*) (44,47). In terms of ABO blood types and bacteria species, the data showed that *E. coli* was the most pathogen causing UTI among patients with O blood group followed B blood group. Gram negative bacteria have highest frequency in patients with O and B blood groups than other blood groups. This agree with other study revealed that *E. coli* was the most common pathogen causing UTI among O blood groups patients ((18.8%) (32). It also demonstrated that *E. coli* was the most prevalent bacteria discovered in all ABO blood groups of UTI patients (41). Additionally, according to Lewis blood phenotypes the results revealed that *E. coli* had the highest prevalence among UTI patients with Le (a-b-) phenotype than other Lewis phenotypes. Lewis blood groups, as well as ABO blood groups, had a significant connection with urinary tract pathogens ($P<0.05$). Gram negative bacteria were more common with highest frequency in patients with Le (a-b-) phenotype patients than other Lewis phenotypes. These agree with other investigations have found that the Lewis negative phenotype Le (a-b-) is related with an increased vulnerability to *Escherichia coli* infections (48).

Conclusions

It was concluded that ABO and Lewis blood types as well as secretor status have a great association with susceptibility to infected with urinary tract infection. Urinary tract infection more prevalent in patients with blood group O and Lewis blood group phenotype Le (a-b-) in addition of secretor status. The most frequent pathogen is *E. coli* as well as gram negative bacteria among UTI patients where increased in blood group O as well as Lewis blood group phenotype Le(a-b-) patients an compared with other blood groups.

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