

Original Research

## Immediate, 6-hours and 24-hours urethral catheter removal on urinary morbidity following elective caesarean delivery under spinal anaesthesia: A randomized comparative study.

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### Abstract

**Background:** Urethral catheterization is a common practice during caesarean delivery. Prolonged use may lead to urinary tract infection, the duration of catheterization being critical to its development. The optimal time for its removal after caesarean delivery remains undecided. This study compared the effect of immediate, 6-hours and 24-hours removal post-elective caesarean delivery on significant bacteriuria, re-catheterisation, interval to first micturition and maternal discomfort.

**Methodology:** The study was conducted at a tertiary hospital in Port Harcourt, Nigeria. A total of 150 women who had elective caesarean delivery were randomised into 3 groups using computer-generated random sequence numbers. Group A – had the urethral catheter removed immediately, Group B – after 6 hours, and Group C – after 24 hours post-operation. The women were assessed for significant bacteriuria and need for re-catheterisation as the primary outcomes; interval to first micturition and maternal discomfort as the secondary outcomes. Data was analysed using IBM SPSS version 23.

**Results:** Overall incidence of significant bacteriuria was 12%. The difference in incidence was 0(0%), 6(12%), and 12(24%) for the Immediate, 6-hours and 24-hours groups respectively, ( $p < 0.001$ ). Urinary retention requiring re-catheterization was also significant, highest in the Immediate group 8(14%), 2(4%) in the 6-hours group and none in the 24-hours group. The mean interval to first micturition was highest in the 6-hour group, least in the 24-hour group and intermediate in the Immediate group ( $9.52 \pm 6.26$ ,  $5.16 \pm 3.80$ , and  $6.92 \pm 3.36$ , respectively  $< 0.001$ ). Most participants had mild discomfort, and the difference between groups was insignificant ( $p = 0.445$ ).

**Conclusion:** Immediate catheter removal had a lower risk of significant bacteriuria but increased urinary retention, while the 24-hour removal had reduced urinary retention but was fraught with significant bacteriuria. The 6-hour removal had a modest risk for both significant bacteriuria and urinary retention. The 6-hours removal offers a balance and should be a safer option.

**Keywords:** Caesarean Delivery; Urethral Catheterisation; Urinary Tract Infection; Urinary Retention; Maternal Discomfort; Significant Bacteriuria; Spinal Anaesthesia.

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## Introduction

Postoperative urethral catheterization following caesarean delivery is indicated to avoid urinary retention, prevent uterine atony due to a full bladder, and circumvent the need to get out of bed while still recovering from anaesthesia [1,2]. The surgical procedure, the use of regional anaesthesia, and physiological changes in pregnancy predispose women post-caesarean delivery to develop urinary retention [3]. Urethral catheterization, though useful in preventing urinary retention, may predispose the patient to catheter-acquired urinary tract infection [4]. The timing of catheter removal may play a role in the development of urinary tract infections. The daily risk of developing infection ranges from 3-8% for each day the catheter is left in place and increases with prolonged catheterization [5]. Hence, the need for appropriate timing of urethral catheter removal post-caesarean delivery.

A study [6] had shown that bladder function following spinal anaesthesia is about 80% regained after eight hours and implies a better safety profile to remove the catheter after 6-8 hours. However, this has not gained validation and popular clinical application. Very early removal of the urethral catheter may increase the risk of urine retention that will warrant re-catheterization [7-9]. Previous studies using interventions like non-catheterization, immediate removal, 2-hour removal, 6-hour removal, 8-hour removal, and even 24-hour removal after caesarean delivery have all reported urine retention morbidity [7-14].

The longer the duration that an indwelling catheter is retained in the bladder, the more likely the occurrence of significant bacteriuria that may result in urinary tract infection (UTI) [14-16], but the less likelihood of urinary retention following caesarean delivery under spinal anaesthesia. Currently, there is no consensus on the specific time to remove a catheter following caesarean delivery. Therefore, it is imperative to find a balance between the duration of retaining a catheter that will combine a lesser incidence of urinary retention with the advantage of reduced bacteriuria.

The routine practice in our Centre is to catheterize all women undergoing caesarean delivery, and the urethral catheter is retained for 24 hours, which could be retained for more than 24 hours depending on the patient's condition. There is no management protocol on the use of a urethral catheter in women undergoing caesarean delivery. Therefore, there is a need for an evidence-based decision on whether the routine retention for 24 hours is to be changed, and there is no consensus in existing literature. The study, therefore, aimed to compare the outcome of immediate and six-hour removal versus 24-hour removal of urinary catheter in terms of significant bacteriuria, urinary retention necessitating re-catheterization, interval to first micturition post-removal and maternal discomfort, following caesarean section under spinal anaesthesia. The knowledge gained will inform the development of a protocol on the timing of removal of the urethral catheter post caesarean delivery and add to the general knowledge aimed at reaching a consensus.

## Methodology

**Study setting:** The study was conducted at the Department of Obstetrics & Gynaecology of the Rivers State University Teaching Hospital (RSUTH), Port Harcourt, Nigeria. The institution is a state-owned tertiary hospital and serves as a referral centre for primary and secondary healthcare facilities as well as private hospitals. The institution provides for the healthcare needs of neighbouring states as well. The hospital is an accredited training Centre for undergraduate and postgraduate doctors. There is an average annual delivery rate of approximately 1800, with a reported caesarean section rate of 43.1% [17].

Ethical clearance was obtained from the Research and Ethics Committee of the RSUTH with approval number RSUTH/REC/2022193. All the participants gave written informed consent, and the study was conducted in accordance with the Declaration of Helsinki and International Conference on Harmonization of Good Clinical Practice.

**Aims and Specific objectives:**

The study aimed to compare the outcome of immediate and six-hour removal versus 24-hour removal of urinary catheter in terms of significant bacteriuria, urinary retention necessitating re-catheterization, interval to first micturition post-removal and maternal discomfort, following caesarean section under spinal anaesthesia.

**Study design:**

This was an open-labeled randomized comparative study. The study was conducted between July 2022 and March 2023.

**Study population:** The study population comprised all women scheduled for elective caesarean section under spinal anaesthesia at the RSUTH, who met the inclusion criteria.

**Inclusion criteria:** All booked and consenting mothers,  $\geq 18$  years of age, with singleton pregnancies and absence of preoperative significant bacteriuria or UTI, who had an elective (primary or repeat) caesarean delivery under spinal anaesthesia.

**Exclusion criteria:** Women with diabetes, renal disease, HIV-positive, sickle cell disease, UTI or who were receiving antibiotics for any infection prior to caesarean delivery. Also, women with pre-eclampsia with severe features/eclampsia, preterm/prolonged rupture of fetal membrane, intra-operative bladder injury, conversion to general anaesthesia, and those who did not consent were excluded.

**Intervention and Outcomes:** One hundred and fifty (150) women were randomly allocated to three groups of 50 each. Group A had their urinary catheter removed immediately after the operation, Group B 6 hours after, and Group C 24 hours after. The primary outcomes were the occurrence of significant bacteriuria and acute urine retention warranting re-catheterization after removal. The secondary outcomes were the Mean interval at first micturition post-urethral catheter removal and maternal discomfort among the participants.

**Sample size determination:** The sample size for the study was determined using the formula for comparison of groups[18].

$$n = \frac{3(u + v)^2(S1^2 + S2^2)}{(\mu1 - \mu2)^2}$$

Where, n = minimum sample size for each of the three groups; u = standard deviation of normal distribution for the power of 90% corresponding to  $u=1.28$ ; v = standard deviation of normal distribution corresponding to the significance level of 95% corresponding to  $v = 1.96$ ; S1 = standard deviation of outcome in the intervention group; the standard deviation of time to the first voiding in the intervention group was 14.3 in a similar Nigerian study[13]. S2 = standard deviation of outcome in the control group; the standard deviation of time to first voiding in the control group was 18.3 in the same Nigerian study [13].  $\mu1$  = mean outcome in the intervention group; the mean time to first voiding in the intervention group was 211.4 in a similar Nigerian study [13].  $\mu2$  = mean outcome in the control group; the mean time to first voiding in the control group was 190.0 in a similar Nigerian study [13]. Substituting in the formula:

$$n = \frac{3(1.28 + 1.96)^2 (14.3^2 + 18.3^2)}{(211.4 - 190.0)^2} = n = 37.1 \approx 38 \text{ per group.}$$

Allowing for 10% attrition (3.8), the sample size for each group was 42, which was rounded to 50. Therefore, a total of 150 participants (50 per group) were recruited for the study.

### **Recruitment, Randomization and Allocation:**

Potentially eligible women booked for elective caesarean delivery at the antenatal clinic were counselled and verbal consent obtained from those who indicated interest in participating. The recruited participants were taught how to collect a clean-catch midstream urine sample that was sent for microscopy, culture and sensitivity. Those with significant bacteriuria/UTI were excluded from the study and given appropriate treatment. Those without significant bacteriuria that met the inclusion criteria were counselled again on admission to the antenatal ward for elective caesarean section, and a written informed consent was obtained. A proforma was used to obtain information from the participants.

The allocation sequence was based on computer-generated random numbers. The allocation for each group (A, B, or C) were then labeled on a piece of paper, according to the number sequence for the group, and put into consecutively numbered opaque brown envelopes (marked 1 to 150). The envelopes were stored and unsealed in the theatre; when the patient picked a number from the ballot box, the appropriate envelope was opened to reveal the allocated group (A, B, or C). Group A had their urinary catheter removed immediately after completion of skin closure, Group B 6 hours after completion of skin closure, and Group C 24 hours after completion of skin closure. In all cases and at the appropriate time, the obstetrician, the nurse or resident doctors who were trained for the study removed the urethral catheter. The medical microbiologists and scientists were not aware of the different timing of catheter removal, as the urine sample bottles only bore the allocation number.

### **Study procedures:**

The women were catheterized on the theatre table, before administration of spinal anaesthesia, under an aseptic procedure with a size 16 French gauge Foley's urethral catheter. Prophylactic intravenous antibiotic as Ceftriaxone, one gram statim, was given to all the participants before skin incision. The surgery was carried out by either a consultant or senior registrar, and a lower-segment uterine incision was used for every participant. All aspects of postoperative care were according to the standard hospital practice. Postoperative intravenous fluids were given for 24 hours as the participants were on nil per oral until bowel sounds returned. Intravenous prophylactic antibiotics were given for 48 hours as ceftriaxone 1 gm daily and metronidazole 500mg 8 hourly. Postoperative analgesia was given as IV pentazocine 30mg 6 hourly, IM Paracetamol 600mg 8 hourly, and suppository Diclofenac 100mg 12 hourly, all for 48 hours.

The urethral catheter was removed at different times after the surgery as described earlier. A urine sample was collected for urinalysis, microscopy, culture, and sensitivity at 48 hours post-operation to assess for bacteriuria. The samples were sent to the medical microbiology laboratory within 30 minutes of collection; samples collected late, after closure of the laboratory for routine specimens, were stored in a refrigerator at 4°C till morning.

The urine was cultured on Cysteine Lactose Electrolyte Deficient (CLED) Agar medium. The urine samples not cultured within 2 hours were stored at 4 °C. The inoculated CLED culture plate was incubated at 37 °C for 24 hours. After the 24 hours incubation period, the culture plate was enumerated for bacterial population count. Samples yielding colony counts with a growth of 10<sup>5</sup>cfu/ml or more pure isolates were considered significant. This was followed by an antibiogram for drug sensitivity. Participants who were diagnosed with UTI were counselled and treated with appropriate antibiotics.

The participants were assessed for the outcome measures of postoperative urinary retention, time to first micturition after catheter removal, and maternal discomfort. The participants were encouraged to empty their bladder after catheter removal. In the event of urinary retention, the catheter was re-inserted and removed after 24 hours. The discomfort was defined as burning or pain at voiding, determined using the numerical version of the Visual Analog Scale (VAS). It consisted of a 10cm line with two points representing 0 and 10, where 0 represents no pain and 10 represents the worst possible pain. The discomfort was categorized as mild when the score was 0-3, moderate when 4-6 and severe when 7-10. The participants were asked to mark the point on the scale that best suited their discomfort. The time of first micturition was measured as the time from urethral catheter removal to first voiding.

### **Definition of terms:**

*Significant bacteriuria* was diagnosed when one or more organisms are present at quantitative counts  $\geq 10^5$  cfu/ml from a clean catch midstream urine specimen in a patient with no symptoms attributed to UTI [14,19].

*Urinary tract infection* was diagnosed when significant bacteriuria was associated with symptoms or signs not attributable to any other identifiable cause, associated with any of fever, frequency, urgency, dysuria, suprapubic tenderness or costovertebral angle pain [14,20].

*Urinary retention* was defined as the inability to void after removal of a urethral catheter for up to six hours or necessitating re-catheterization for relief [7].

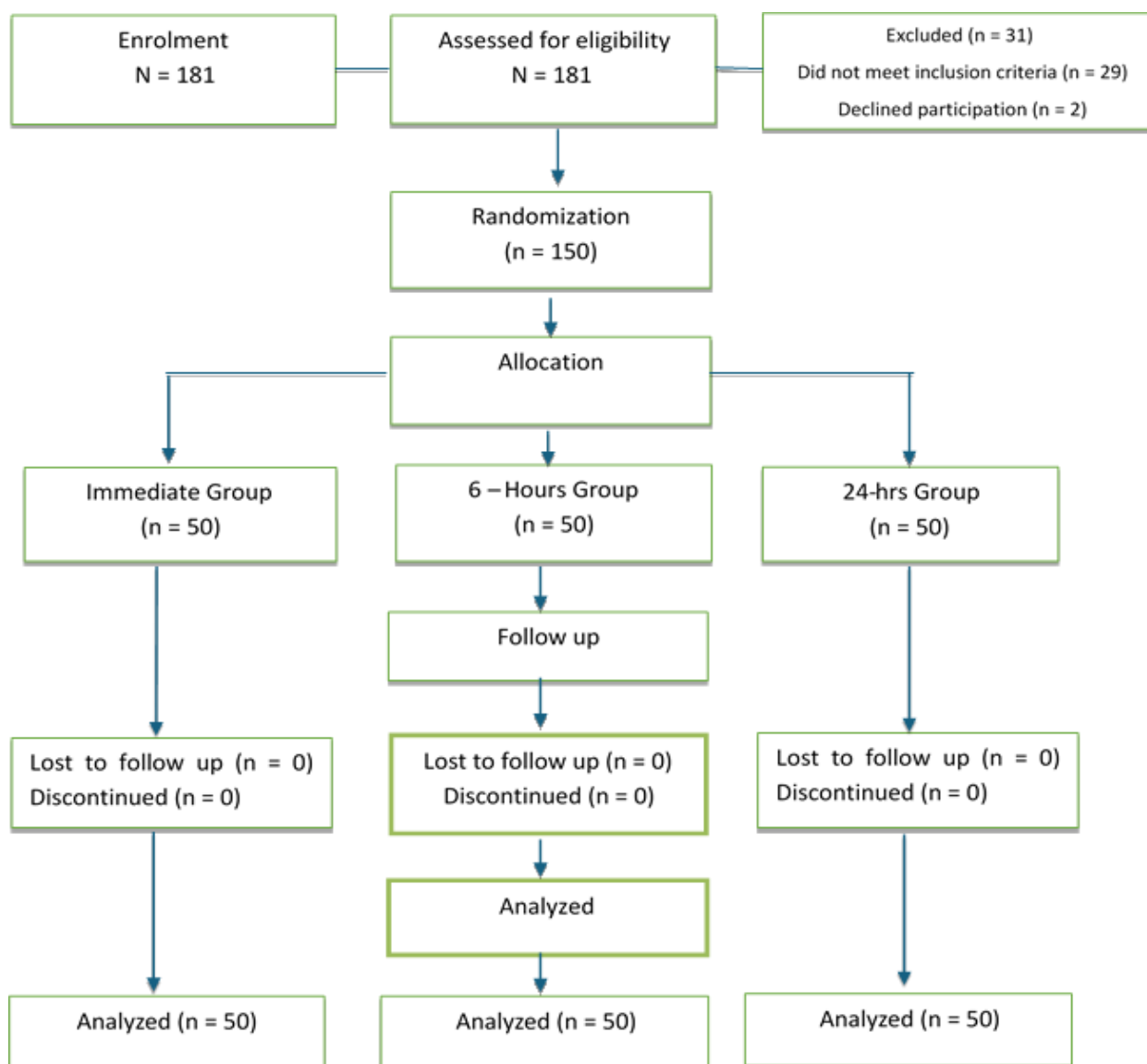
*Interval to first micturition* was defined as the time until the first spontaneous voiding was observed after urethral catheter removal.

### **Data analysis:**

Data were analyzed using IBM SPSS version 23 (IBM Corp., Armonk, NY, USA). Categorical data were presented in tables as frequencies and percentages. Continuous data were summarized with mean  $\pm$  standard deviation. The one-way analysis of variance (ANOVA) was used to determine the differences in the means of numerical variables across the three groups in the study. The difference in observed proportions of the outcome variables across the groups was compared using Pearson's Chi-Square test when the expected cell count was more than five or Fisher's exact test if the expected cell count was below five. The level of statistical significance was set at a  $p$ -value  $< 0.05$ .

### **Results:**

A total of 181 women were enrolled and assessed for eligibility for the study. Thirty-one women were excluded from the study; twenty for not meeting the inclusion criteria, nine had significant bacteriuria, and two of the women did not consent to participate. One hundred and fifty (150) participants were randomized into the three groups and were all available for analysis at the end (Figure 1). The study was conducted from the 18th of July 2022 to the 5th of March 2023.



**Figure 1: CONSORT flow diagram of study.**

Table 1 shows the socio-demographic characteristics of the study population. The majority of the participants in each of the groups were aged 30-39 years; 36(72.0%), 37(76.0%), and 38(74.0%) in the Immediate, 6-hours and 24-hours groups, respectively. Most of the women had tertiary education 41(82.0%), 44(88.0%), and 44(88.0%); had gestational age at delivery of 37-40 weeks 45(90.0%), 48(96.0%), and 44(88.0%); and parity of 2-3, 32(64.0%), 32(64.0%), and 29(58.0%); respectively. There were no significant differences in the socio-demographic characteristics across the three groups in terms of maternal age, education, gestational age, and parity ( $p=0.959$ ;  $p=0.793$ ;  $p=0.549$ ; and  $p=0.916$ ), respectively. Regarding the intra-operative events across the three groups, there was no significant difference in the mean duration of surgery ( $0.66\pm 0.36$ ,  $0.64\pm 0.34$ , and  $0.63\pm 0.34$  for Immediate, 6-hour and 24-hour, respectively;  $F=0.143$ ;  $p=0.867$ ) and the mean volume of fluid received intra-operatively ( $2.14\pm 0.55$ ,  $2.12\pm 0.51$ , and  $2.12\pm 0.62$  for Immediate, 6-hour and 24-hour, respectively;  $F=0.030$ ;  $p=0.970$ ).

**Table 1: Sociodemographic characteristics and intra-operative events of the study groups.**

Variables	Immediate N = 50 n (%)	6-hours N = 50 n (%)	24-hours N = 50 n (%)	Total N = 150 n (%)	Fisher's exact test (p-value)
<b>Maternal age</b>					
<20 years	0 (0.0)	1 (2.0)	0 (0.0)	1 (0.7)	2.685
20 – 29 years	10 (20.0)	7 (14.0)	8 (16.0)	25 (16.7)	(0.959)
30 – 39 years	36 (72.0)	38 (76.0)	37 (74.0)	111 (74.0)	
≥ 40 years	4 (8.0)	4 (8.0)	5 (10.0)	13 (8.7)	
<b>Education</b>					
None	1 (2.0)	0 (0.0)	0 (0.0)	1 (0.7)	2.386
Secondary	8 (16.0)	6 (12.0)	6 (12.0)	20 (13.3)	(0.793)
Tertiary	41 (82.0)	44 (88.0)	44 (88.0)	129 (86.0)	
<b>Occupation</b>					
Housewife	5 (10.0)	1 (2.0)	4 (8.0)	10 (6.7)	5.492
Trading	1 (2.0)	0 (0.0)	0 (0.0)	1 (0.7)	(0.454)
Civil servant	2 (4.0)	3 (6.0)	4 (8.0)	9 (6.0)	
Others	42 (84.0)	46 (92.0)	42 (84.0)	130 (86.7)	
<b>Gestational age</b>					
<37 weeks	2 (4.0)	1 (2.0)	4 (8.0)	7 (4.7)	3.020
37 – 40 weeks	45 (90.0)	48 (96.0)	44 (88.0)	137 (91.3)	(0.549)
>40 weeks	3 (6.0)	1 (2.0)	2 (4.0)	6 (4.0)	
<b>Parity</b>					
1	12 (24.0)	10 (20.0)	13 (26.0)	35 (23.3)	0.957
2 – 3	32 (64.0)	32 (64.0)	29 (58.0)	93 (62.0)	(0.916)
≥4	6 (12.0)	8 (16.0)	8 (16.0)	22 (14.7)	
<b>Intraoperative events</b>					
Duration of surgery (hours)	Mean SD 0.66±0.36	Mean SD 0.64±0.34	Mean SD 0.63±0.34		ANOVA (p-value) 0.143 (0.867)
Fluid volume received (Litres)	2.14±0.55	2.12±0.51	2.12±0.62		0.030 (0.970)

\*Statistically significant( $p < 0.05$ )

SD – Standard deviation

Table 2 shows the incidence of significant bacteriuria/UTI among the groups. There was an overall incidence of significant bacteriuria (positive culture) in 18(12%), with a statistically significant difference observed in the incidence across the groups, 0(0.0%), 6(12.0%) and 12(24.0%) in the Immediate, 6-hours and 24-hours urethral catheter removal groups respectively ( $\chi^2=8.769$ ;  $p < 0.001$ ). However, there was no significant difference in the incidence of UTI with respect to clinical features (fever after 24 hours and costovertebral tenderness) in the Immediate, 6-hours and 24-hours urethral catheter removal groups ( $\chi^2=2.098$ ;  $p=0.350$ ) and ( $\chi^2=2.055$ ;  $p=0.358$ ) respectively.

**Table 2: Urinary morbidity in terms of UTI across the three groups.**

Variables	Immediate n(%)	6-hour n(%)	24-hour n(%)	Total n(%)	Chi-Square (p-value)
<b>Bacteriuria 10<sup>5</sup></b>					
Positive	0(0.0%)	6 (12.0%)	12(24.0%)	18(12.0%)	8.769
Negative	50(100%)	44(88.0%)	38(76.0%)	132(88.0%)	(0.001*)
<b>Total</b>	50(100%)	50(100%)	50(100.0%)	150(100.0%)	

<b>Fever after 24hrs</b>					
Yes	4(8.0%)	1(2.0%)	2(4.0%)	7 (4.7%)	2.098
No	46(92.0%)	49(98.0%)	48(96.0%)	143(95.3%)	(0.350)
<b>Total</b>	50(100%)	50(100%)	50(100%)	150(100%)	
<b>Costovertebral tenderness</b>					
Yes	2 (4.0%)	2 (4.0%)	0 (0.0%)	4(2.7%)	2.055
No	48 (96.0%)	48 (96.0%)	50 (100.0%)	146(97.3%)	(0.358)
<b>Total</b>	50 (100.0%)	50 (100.0%)	50 (100.0%)	150(100%)	

\*Statistically significant ( $p < 0.05$ )

From Table 3, the overall incidence of postoperative urine retention was 10(6.7%), with a significant difference in the incidence of urinary retention requiring re-catheterization; 8(16.0%), 2(4.0%) and 0(0.0%) in the Immediate, 6-hours and 24-hours urethral catheter removal groups respectively ( $\chi=11.774$ ;  $p=0.004$ ). However, there was no significant difference with respect to bladder distension 8(11.0%), 5(10.0%) and 1(2.0%) in the immediate, 6-hours and 24-hours urethral catheter removal groups ( $\chi=5.830$ ;  $p=0.054$ ). There was a significant difference in the incidence of urinary retention with respect to the inability to pass urine 10(20.0%), 11(22.0%) and 0(0.0%) in the Immediate, 6-hours and 24-hours urethral catheter removal groups respectively ( $\chi=12.292$ ;  $p=0.002$ ).

**Table 3: Urinary morbidity in terms of retention across the three groups.**

Variables	Immediate n=50 N(%)	6-hour n=50 N(%)	24-hour n=50 N(%)	Total n=150 N(%)	Chi-Square (p-value)
<b>Catheter re-inserted</b>					
Yes	8 (16.0%)	2 (4.0%)	0 (0.0%)	10 (6.7%)	11.143
No	42 (84.0%)	48 (96.0%)	50 (100.0%)	140 (93.3%)	(0.004*)
<b>Bladder distension</b>					
Yes	8 (16.0%)	5 (10.0%)	1 (2.0%)	14 (9.3%)	5.830
No	42 (84.0%)	45 (90.0%)	49 (98.0%)	136 (90.7%)	(0.054)
<b>Inability to pass urine</b>					
Yes	10 (20.0%)	11 (22.0%)	0 (0.0%)	21 (14.0%)	12.292
No	40 (80.0%)	39 (78.0%)	50 (100.0%)	129 (86.0%)	(0.002*)

\*Statistically significant ( $p < 0.05$ )

Regarding the Mean interval to first micturition after catheter removal in hours, there was a significant difference in the Immediate, 6-hours and 24-hours group ( $6.92 \pm 3.36$ ,  $9.52 \pm 6.26$ , and  $5.16 \pm 3.80$ , respectively;  $F=11.131$ ;  $p < 0.001$ ). The overall mean time (hours) of first voiding in this study was  $7.20 \pm 4.96$  hours.

Table 4 shows a comparison of patient's discomfort across the study groups. Overall, there was no significant difference in the patients' discomfort between the immediate, 6-hours and 24-hours urethral catheter removal groups ( $\chi=5.590$ ;  $p=0.471$ ). Most of the participants, 60(40.0%), expressed no discomfort at all; half of the 6-hour group patients (25/50) were in this category. Of those expressing moderate (4-6) discomfort, 24(16%) of the participants, half of them were in the Immediate removal group (12/24). Four of the eight participants who expressed severe (7-10) discomfort were in the 24-hour removal group. Over a third of the participants in each group expressed mild (1-3) discomfort.

**Table 4: Comparison of patients' discomfort across the study groups.**

	Immediate	6-hour	24-hour	Overall
Rating of patient discomfort	N = 50	N = 50	N = 50	N = 150
	n (%)	n (%)	n (%)	n (%)
0	17 (34.0)	25 (50.0)	18 (36.0)	60 (40.0)
1 – 3	18 (36.0)	18 (36.0)	22 (44.0)	58 (38.7)
4 – 6	12 (24.0)	6 (12.0)	6 (12.0)	24 (16.0)
7 - 10	3 (6.0)	1 (2.0)	4 (8.0)	8 (5.3)

*Chi Square = 5.590; p-value = 0.471*

### Discussion:

The time of removal of the urethral catheter is important to prevent urinary morbidity that could arise from prolonged catheterization or too early removal. Thus, there is a need to balance the risks and benefits of non-use, early or delayed removal. This study found that immediate removal was associated with the most urinary retention and 24-hour removal with the highest incidence of significant bacteriuria, while both morbidities were modest with the 6-hour removal. Though not significant, more participants in the 6-hour removal group also expressed less discomfort compared to the Immediate and 24-hour removal counterparts.

The overall incidence of significant bacteriuria in this study was 12%, which is comparable with the 9.0% reported by Onyebule et al [14], but lower than the 26.9% reported by Oriji et al [2]. The lower incidence in this study, compared to the later study, could be due to the pre-operative urine culture performed 48 hours before the surgery, leading to exclusion of positive cases, and possibly, improved practice of aseptic techniques in the procedure of catheter insertion.

There was no significant bacteriuria in women who had the urethral catheter removed immediately after surgery in this study; this was less than the 1.4% reported by Dasgupta et al [21], 3.1% reported by Oriji et al [2], and the findings of 6.5% reported by Onyebule et al [14], in their immediate removal study groups. A probable reason for this difference might be the short interval between preoperative urine culture and surgery or the administration of prophylactic antibiotics prior to skin incision, measures that would have aided in reducing bacteriuria. The fact that the differences observed between the studies may be unrelated to catheterization is further strengthened by the finding in a non-catheterized group of 4.0% bacteriuria by Pandey et al [22], and 17.5% in the non-catheterized (spontaneous void) group reported by Oriji et al [2]. The high incidence of significant bacteriuria of 24% in the 24-hour removal group of this study is corroborated by findings of similar studies and buttresses the fact that increased duration of catheterization increases bacterial colonization [6,23]. The rate of significant bacteriuria in the 24-hour group of this study was higher than the 11.4% reported by Onyebule et al [14] and 11.2% reported by Onile et al [11] in their 24-hour groups.

Postoperative urinary retention has been quoted to range between 3.3% to 39.0% in the literature, and the incidence varies depending on the definition used [24]. In this study, using the more objective criteria of re-catheterization and the subjective response of inability to pass urine, the overall incidence of postoperative urine retention was 6.7% and 14.0% respectively. The incidence of urinary retention requiring re-catheterization in the Immediate group was 16.0% and was comparable to 13.6% by Aref et al [25]. This, however, contrasts with the 4.4% and 1.8% in the Immediate group by Oriji et al [2] and

Dasgupta et al [21], respectively. It was also greater than the 4.61% reported by Chowdhury et al [10], 1.2% reported by Onile et al [11], and 4.3% in the 2-hour group reported by Basbug et al [8]. This disparity could be a result of bladder dissection during caesarean delivery, leading to disruption of the bladder innervation. It could also be due to spinal anaesthesia and inadequate analgesia post-operation. The urinary retention of 4.0% in the 6-hour removal group of this study was similar to 5.47% in the uncatheterized group reported by Nasr et al [26], although the majority of the participants in their study received general anaesthesia. The finding that over 90% of the 6-hour group regained bladder function within 8 hours following spinal anaesthesia agrees with the urodynamic study by Zanfini et al [6], who showed that up to 80% of bladder function is recovered by the 8<sup>th</sup> hour post spinal anaesthesia. Therefore, the 6-hour urethra catheter removal in this study had a lower risk for urine retention compared to the immediate removal.

There was no statistically significant difference in the expression of discomfort between the groups. This contrasts with the study by Pandey et al, where the urethral catheter group had 85.3% discomfort [22]. However, in this study, we observed a pattern of at least half (12/24) of those expressing moderate discomfort belonging to the Immediate removal group and half (4/8) of those who experienced severe discomfort from the 24-hour group. Perhaps the sample size was too small to power a significant difference. The expression of more discomfort in the Immediate removal group may not be unrelated to the increased urinary retention requiring re-catheterization, and in the 24-hour group may be related to the inability of the participants to freely move around the ward as they have to drag along with them their urine bags, a view that was expressed by Igbodike et al [13].

A systematic review by Li et al [7] found that an indwelling catheter was associated with a longer interval to voiding after catheter removal. This study also found significant differences between the study groups. The time to first voiding of  $6.92 \pm 3.36$  hours in the Immediate group in this study was comparable to  $7.64 \pm 3.61$  hours and  $6.48 \pm 0.82$  hours in the non-catheterized group in the study by Nasr et al [26] and Pandey et al [22]. The voiding time in our Immediate group was comparable to the non-use of a urethral catheter. The mean first voiding time in the Immediate group of this study was, however, higher than the  $4.8 \pm 1.1$  reported by EL-Mazny et al [27]. Although the mean voiding time in our 6 hours group ( $9.52 \pm 6.26$ ) was higher than that of the Immediate group, this might be related to a fear of getting up from bed to void and developing spinal headache. It could also be that the delay in voiding after catheter removal might be a result of the transient loss of bladder control following catheterization under spinal anaesthesia as advanced by Zanfini et al [6]. It is yet to be shown if the urethral catheter itself influences the interval at voiding, irrespective of the demonstrated spinal anaesthetic effect [13].

### **Limitations and strengths:**

This study was single centre based in an urban tertiary hospital and therefore limited in generalizability. Also, only elective caesarean sections were included; emergencies were excluded due to the difficulty in getting urine culture results before enrollment. Furthermore, postoperative fluid intake was not quantified or analysed, and postoperative antibiotics were given to all the participants as ethically required and may have affected the overall testing for significant bacteriuria. The randomization of the participants to reduce recruitment bias and blinding of the medical microbiologists to urine culture specimens were strengths of the study.

### **Conclusion:**

This study found that immediate catheter removal had a lower risk of significant bacteriuria but was associated with increased urinary retention. The 24-hour removal had reduced incidence of urinary retention but was fraught with increased risk of significant bacteriuria. The 6-hour removal had a modest risk for both significant bacteriuria and urinary retention. The 6-hours removal offers a balance and should be a safer option in the timing of urethral catheter removal post-elective caesarean delivery.

A multi-centre study with a larger sample size is recommended to validate these findings and other variables should compare those with previous experience with urethral catheterization and those without any experience.

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