ORIGINAL

Impact of early urinary catheter removal on successful voiding and physical function in stroke patients

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Abstract : Objective : The aim of the present study was to identify factors related to the success of trial without catheter (TWOC) in patients with stroke and to examine the effect of the timing of urinary catheter removal on the course of stroke. Methods : Patients who were admitted to the Stroke Care Unit of our institution between March 2018 and October 2021 were included. To identify factors related to success of TWOC, a multivariate analysis was performed on the patient's condition at admission and catheter indwelling time. The patients were divided into two groups by the timing of catheter removal, and we assessed the relationship between the timing of catheter removal successful TWOC and recovery of physical function. Results : A total of 118 patients were included. The presence of comorbidities and scores of severity and function at admission were not predictors of successful voiding. The time to achieve voiding sussess was significantly shorter in the early catheter removal group than in the later group ($p<0.005$). Interestingly, the early group also showed better improvements in physical function. Conclusion : Early removal of catheters may lead to early recovery of bladder function, improvement of physical function, and lower risk of complications in patients with stroke. J. Med. Invest. 70 : 436-442, August, 2023

Keywords **:** *Urinary catheter, voiding function, physical function, stroke*

INTRODUCTION

Lower urinary tract dysfunction is a common complication of cerebrovascular disease (1). Dysuria is particularly likely to occur during the early weeks after onset, and urinary retention occurs in 20–50% of poststroke patients (2, 3). To direct brain damage, such as damage to the cerebral cortex, which leads to dysfunctions in the control of voiding, and/or damage to the cerebellum and thalamus, which is associated with the dysfunction of the pontine micturition centers, was caused dysuria (4). In addition, the inability to communicate the urge to urinate, impaired consciousness, temporary overinflation of the bladder, and restricted movement can affect dysuria after a cerebrovascular accident (2). The risks of stroke, such as diabetes, aging, sex, and physical inactivity, are associated with the risk of developing dysuria (5). Many of these factors directly affect urinary function. Thus, the involvement of many factors other than neurological ones makes it difficult to explain the pathology.

Urinary catheters are often necessary in stroke patients because of acute urinary retention, the need for accurate urine output measurement in critically ill patients, and perioperative use during surgical procedures (6). Although urinary retention that occurs immediately after stroke often improves with time (2, 7), it can persist for a long time, especially in patients with diabetes, impairing activities of daily living (ADL), walking ability, and communication skills (2, 8).

Dysuria after stroke can lead to complications, such as urinary tract infection, urinary stones, and renal dysfunction (4, 9, 10) ; thus, appropriate measures must be taken. In the chronic phase, a urinary catheter should be placed only if the patient is refractory to treatment, and intermittent urinary drainage is desirable when it is possible (4, 6, 11). However, stroke patients may suffer from paralysis or cognitive decline, which makes continence self-management difficult and requires continuous catheterization (12). This condition reduces the rate of hospital discharge and increases the psychological and social burden on patients, caregivers, and their family members (13, 14).

Furthermore, urinary catheter placement has been reported to be associated with lower activity during hospitalization in the elderly (15), and catheter placement and urinary tract infections in stroke patients have been shown to interfere with rehabilitation (16). Thus, stroke guidelines recommend early rehabilitation in environments with organized, interprofessional stroke care (11). However, there is no established management for poststroke dysuria.

The purpose of this study was to clarify the factors related to the success of the trial without catheter (TWOC) and to assess the effect of the timing of urinary catheter removal on voiding success and the course of stroke.

MATERIALS AND METHODS

Subjects

Patients who had strokes, were admitted to the Stroke Care Unit of our institution between March 2018 and October 2021, and had an indwelling urinary catheter were included in this retrospective study. Patients with subarachnoid hemorrhage, unknown stroke onset time, hemodialysis, advanced malignancy, or missing data at admission were excluded. Patients who died during hospitalization or who underwent transurethral surgery were also excluded. Patients were excluded if they did not have dysuria, defined as residual urine of ≥ 50 mL immediately after removal of the urethral catheter (Figure 1).

Management of urinary drainage

The stroke rehabilitation program was indicated within 3

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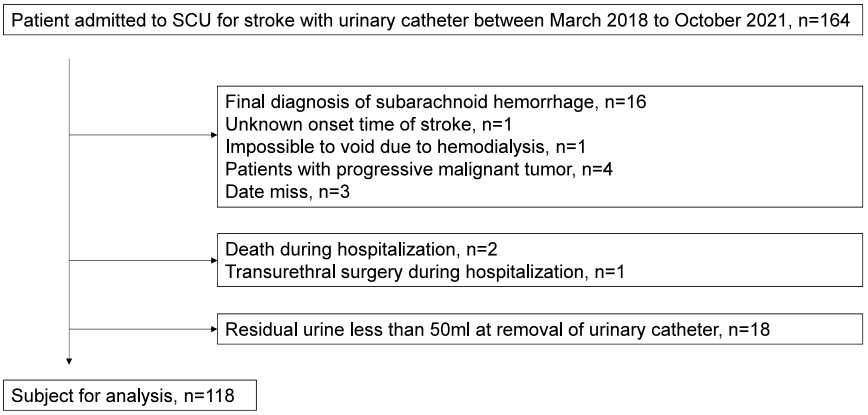

Figure 1. Flowchart of patient selection

days of admission. The timing of removal of the urinary catheter was determined when strict fluid output and balance checks were no longer necessary, there was no evidence of UTI, and the daily urine output was less than 1.5 L. If one of these conditions corresponded to the patient, the nurses of the Stroke Care Unit consulted the urinary care team, including the physician, about when to remove the catheter. After reaching consensus, the urinary catheter was removed as soon as possible. Once the catheter was removed, the diapers were checked every hour for the presence or absence of micturition. Post-voiding residual urine was measured by a well-trained nurse using a portable ultrasound bladder scanner, Lilliam α-200® (Otsuka Pharmaceutical Factory, Inc., Tokyo, Japan). If there was significant urinary retention (≥ 150 mL residual urine), intermittent catheterization was performed. Within 24 hours after urethral catheter removal, residual urine after voiding was measured at least four times a day using a portable bladder scanner, and intermittent catheterization was performed if the residual urine after voiding was greater than 150 mL. When over 24 hours elapsed after the urethral catheter was removed, if the residual urine after discharge was decreased, measurements were taken less often. Intermittent catheterization was discontinued when the post-voiding residual urine was consistently less than 150 mL more than a day, and this condition was defined as successful TWOC. However, if intermittent catheterization was needed again during hospitalization, the state of TWOC was failure. Re-catheterization was determined by the treating physician or urologist responsible for the management of urinary drainage. Re-intermittent catheterization and Re-catheterization were defined as unsuccessful TWOC.

Clinical information

Patient data such as age, sex, height, weight, body mass index (BMI), type of stroke (ischemia, non-traumatic hemorrhage), length of hospitalization, time from admission to first removal of urinary catheter, time from admission to success of TWOC, the incidence of UTIs, and the presence or absence of comorbidities such as diabetes, neurological disease, paralysis, and neuropsychological impairment were obtained from medical records. Stroke severity and functional outcome of activities of daily living (ADL) were measured at admission and discharge using the National Institutes of Health Stroke Scale (NIHSS) and Barthel Index (BI). To evaluate physical disability, the modified Rankin scale (mRS) was used prior to admission, at admission, and at discharge. The data collected were compared and analyzed for the successful and non-successful voiding groups. In addition, to assess the impact of the timing of urinary catheter removal, patients who achieved voiding success were compared and analyzed as two subgroups : those with urinary catheters in place for < 6 days and those with catheters in place for ≥ 6 days, 6 days was approximate average of catheter indwelling time.

Statistical Analysis

Patient characteristics in the successful and unsuccessful TWOC groups, or in the < 6 days and ≥ 6 days of catheter insertion groups, were compared using Fisher's exact test for categorical variables and the Mann–Whitney U test for continuous variables. Multivariate logistic regression analysis was used for the multivariate analysis. The cumulative incidence was assessed using the Gray test to describe the effect of catheter removal timing on voiding success. All statistical analyses were performed using EZR (Saitama Medical Center, Jichi Medical University, Saitama, Japan). Statistical significance was set at $p < 0.05$.

RESULTS

A total of 118 patients (65 men and 53 women) were included in this study. Seventy-four of the 118 patients (62.7%) had voiding success at the time of discharge. There were no significant differences in age, sex, and clinical data, such as length of hospitalization, complications, aphasia, or type of stroke, between the voiding success and failure groups. The incidence of UTIs during hospitalization was significantly higher in the voiding failure group (10 vs. 5, $p = 0.02$) (Table 1). Multivariate analysis revealed that the duration of indwelling urinary catheter use significantly affected the success of TWOC (hazard ratio, 2.516, 95% confidence interval, 1.467–4.314, $p = 0.001$) (Table 2).

To assess the impact of the timing of urinary catheter removal on voiding success and physical performance, we divided the patients into two groups (< 6 days vs. ≥ 6 days of catheter insertion). The characteristics at admission of both groups are shown in Table 3, showing no significant difference between the groups except for BMI ($p = 0.026$). The group with catheters placed for less than 6 days showed a significantly shorter time to achieve voiding success of the TWOC (14 median days vs 36 days, $p < 0.01$) (Figure 2). Furthermore, the total NIHSS score was improved at discharge ($p < 0.001$), and the BI ($p < 0.001$) and mRS scores ($p < 0.001$) significantly improved in the early catheter removal group (Table 4).

Table 1. Characteristics of study subjects

	Success of TWOC, n = 74	Non success of TWOC, n = 44	*p*-value
Characteristics on admission			
Age	74.0 ± 9.8	74.0 ± 12.9	0.99
over 75 years old	37 (50.0)	21 (47.7)	
under 75 years old	37 (50.0)	23 (52.3)	
Sex			0.341
Female	36 (48.6)	17 (38.6)	
Male	38 (51.4)	27 (61.4)	
BMI (kg/m²)	23.2 ± 3.8	22.8 ± 3.6	0.513
Stroke type			1
Ischemia	48 (64.9)	28 (63.6)	
Hemorrhage	26 (35.1)	16 (36.4)	
Complications			
Diabetes mellitus	18 (24.3)	11 (25.0)	1
Neurological disorder	29 (39.2)	18 (40.9)	1
Neuropsychological impairment	42 (56.8)	21 (47.7)	0.241
Paralysis	69 (93.2)	40 (90.9)	0.726
Aphasia	38 (51.3)	22 (50.0)	0.851
NIHSS	17.8 ± 10.1	14.6 ± 8.5	0.064
Barthel index	7.0 ± 18.3	3.2 ± 11.1	0.157
mRS before admission			
mRS 0	50	33	0.644
mRS 1	4	5	
mRS 2	5	3	
mRS 3	4	3	
mRS 4	4	0	
mRS 5	0	0	
mRS on admission			0.318
mRS 0	1	1	
mRS 1	0	1	
mRS 2	1	3	
mRS 3	8	2	
mRS 4	18	11	
mRS 5	46	26	
Characteristics during hospitalization			
Hospital stay (day)	26.0 ± 19.8	25.6 ± 15.6	0.904
Catheter indwelling time (day)	6.35 ± 7.80	6.93 ± 8.34	0.709
UTI (%)	5 (6.8)	10 (22.7)	0.02*

Note : Values are presented as mean ± standard deviation or number (%). *p < 0.05
BMI : body mass index ; UT : urinary tract infection. NIHSS : National Institutes of Health Stroke Scale, mRS : Modified Rankin Scale

Table 2. Multivariate analysis of factors associated with TWOC

	HR	95%CI	*p*-value
Age	1.203	[0.745-1.943]	0.449
Sex	1.182	[0.723-1.933]	0.504
Diabetes mellitus	0.948	[0.543-1.654]	0.851
Aphasia	1.165	[0.716-1.893]	0.539
Catheter indwelling time	2.516	[1.467-4.314]	0.001

Note : Age (over 75 years old : 1, under 75 years old : 0). Sex (male : 0, female : 1).
Diabetes mellitus (yes : 1, no : 0). Aphasia (yes : 1, no : 0).
Catheter indwelling time (within 5 days : 1, above 5 days : 0).
Abbreviations : HR, hazard ratio ; CI, confidence interval

Table 3. Characteristics of Patients in early catheter removal and late catheter removal groups

	< 6 days group, n = 71	≥ 6 days group, n = 47	*p*-value
Age	73.7 ± 11.1	74.5 ± 11.0	0.719
Sex			0.341
Female	37 (52.1)	28 (59.6)	
Male	34 (47.9)	19 (40.4)	
BMI (kg/m²)	23.7 ± 3.5	22.1 ± 4.0	0.026
Stroke type			0.117
Ischemia	50 (70.4)	26 (55.3)	
Hemorrhage	21 (29.6)	21 (44.7)	
Complications			
Diabetes mellitus	19 (26.8)	10 (21.3)	0.522
Neurological disorder	27 (38.0)	20 (42.6)	0.702
Paralysis	68 (95.8)	41 (87.2)	0.153
Aphasia	36 (50.7)	24 (51.1)	1
NIHSS on admission	15.7 ± 8.3	18.1 ± 11.4	0.176
Barthel index on admission	7.0 ± 17.3	3.4 ± 13.8	0.229
mRS before admission			0.482
0 points	52	31	
1 points	8	8	
2 points	3	4	
3 points	6	2	
4 points	2	2	
5 points	0	0	

Note : Values are presented as mean ± standard deviation or number (%).
BMI, body mass index ; NIHSS, national Institutes of Health Stroke Scale ; mRS, Modified Rankin Scale

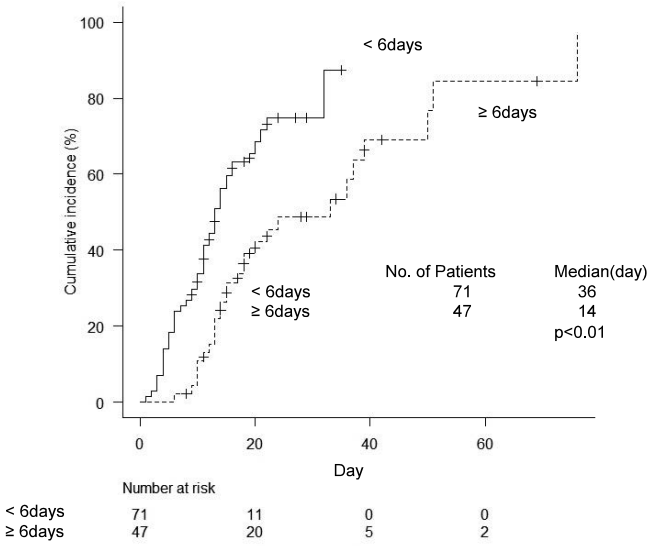

Figure 2. Cumulative incidence for success rate

Table 4. Univariate analysis of variaties associated with physical function and ADL

	< 6 days group, n = 71	≥ 6 days group, n = 47	*p*-value
NIHSS at discharge	8.42 ± 6.44	14.38 ± 9.79	< 0.001*
ΔNIHSS	7.23 ± 9.55	3.74 ± 9.57	0.054
Barthel Index at discharge	37.3 ± 34.5	13.3 ± 20.6	< 0.001*
Δbarthel Index	30.2 ± 33.2	9.9 ± 17.1	< 0.001*
mRS at discharge			< 0.001*
0 points	1	0	
1 points	2	0	
2 points	8	0	
3 points	17	4	
4 points	30	16	
5 points	13	27	

Note : Values are presented as mean ± standard deviation, *p < 0.05
NIHSS : National Institutes of Health Stroke Scale, mRS : Modified Rankin Scale
Δ : difference between admission score and discharge score

DISCUSSION

To identify the factors that interfere with the voiding success of TWOC, we first evaluated the relationship between voiding success at discharge and clinical factors associated with urination, such as age, history of diabetes and hypertension, and neurological assessment. Although men are generally thought to be more likely than women to develop urinary retention due to benign prostatic hyperplasia and complications (17), no association was found between sex and voiding success rate at discharge. Similarly, a history of diabetes, hypertension, and other conditions was not predictive of the voiding success of TWOC. Some previous reports have shown that urinary catheters were more likely to be placed in older patients, patients with higher NIHSS scores on admission, and patients with neurological deterioration (9). In addition, cognitive dysfunction has been reported to be associated with urinary retention (2). However, in the present study, there was no association between the acquisition of voiding success and physical condition before or immediately after stroke onset, or the severity of cerebrovascular disease at the time of admission. In addition, no association was found between successful TWOC and cognitive dysfunction during hospitalization. These results may be explained by the fact that this study focused only on patients who had an indwelling urinary catheter ; therefore, only patients with relatively severe stroke were included.

Urinary catheterization has been reported as a possible risk not only for UTI development but also for complications such as deep vein thrombosis and pneumonia (16, 18). The rate of use of indwelling urinary catheters in stroke patients varies by region

and type of stroke, ranging from 6–60% (9, 16, 19). Stroke has been reported to cause immunodeficiency owing to sympathetic activation and loss of immune cell function (20), and patients with indwelling urinary catheters are particularly susceptible to UTI. In addition, the development of UTI and its associated symptoms, including infection-related fever, hypoxia, and electrolyte imbalance, can impair recovery from stroke and have been reported to be associated with worse neurological outcomes, mortality, poorer recovery of physical function, prolonged hospitalization, and increased post-stroke care costs (20-23). Early rehabilitation in stroke has been shown to improve the long-term recovery of functional abilities and general health (24), reduce long-term mortality and facilitate hospital discharge (25). Complications associated with urinary catheter insertion may interrupt rehabilitation. There are no definitive guidelines regarding the appropriate timing of urinary catheter removal in stroke patients who require catheterization. We therefore assessed the impact of catheter removal timing on the clinical course of stroke patients. The results showed that patients in the early catheter removal group achieved voiding success earlier than those in the later catheter removal group did. The frequency of UTI was significantly lower in the early catheter removal group and, interestingly, the early catheter removal group showed significantly better ADLs and recovery from a stroke at discharge, suggesting that early removal of urinary catheters in stroke patients may lead to effective rehabilitation implementation as well as reduced incidence of UTIs. Early removal of urinary catheters may lead to early recovery of bladder function, improvement of physical function, and lower risk of complications, such as the incidence of UTIs in patients with stroke.

The limitations of this study are as follows. It was a retrospective study, and urinary catheter removal was not defined by protocol, so catheter removal was at the discretion of the treating physician or urologist meaning that the patient's condition could not be ruled out completely. Because patients without catheterization were excluded, comparisons with these patients were not evaluated. The analysis was performed only during acute-care hospitalization, and long-term outcomes were not analyzed. Although rehabilitation was started within 3 days of admission in all patients, the timing of initiation and rehabilitation were not defined by a protocol, and the possibility that rehabilitation differed depending on the patient's condition other than the presence of a catheter cannot be ruled out. Although we found no association between improvement in dysuria and diabetes mellitus, we may have underestimated the impact of diabetes mellitus because we did not confirm the presence of diabetic peripheral neuropathy at the time of stroke onset.

The establishment of appropriate urinary drainage management in stroke patients may lead to improved outcomes, including not only urinary tract management but also functional improvement of patients, and prospective studies are needed.

CONFLICT OF INTEREST DISCLOSURE

Authors have no potential conflict of interest to report.

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