

AN INITIAL EVALUATION OF THE EFFECTIVENESS OF TILT TABLE ON IMPROVEMENT OF URINARY FUNCTIONS IN PARALYZED PATIENTS

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Abstract

Objectives: “Evaluate the effectiveness of tilt table on improvement of urinary functions and prevention of urinary tract infection in paralyzed patients.” **Method:** Group of patients with urinary catheter: 200ml of 0.9% NaCl was entered the bladder then collected output volume. Group of patients with voluntary urination: drunk 500ml of water then performed uroflowmetry test. Patients in both groups performed these procedures in supine position and vertical position (on tilt table). The symptoms of urinary tract infection (UTI) had assessed for 2 weeks in patients urinate voluntarily in supine and vertical position. **Results:** In vertical position with the support of tilt table, patients with urinary catheter had higher urine output and patients with voluntary urination had higher Q_{max} , Q_{ave} and urine output compared to patients in supine position ($p < 0.05$). After 2 weeks of UTI assessment, there were 40% of patient urinate voluntarily in supine position had symptoms of UTI; the amount of white blood cells and neutrophils tended to elevate. There was no symptom of UTI in patients urinate voluntarily in vertical position. **Conclusion:** Tilt table showed initial effectiveness in improving urinary functions and preventing UTI in paralyzed patients.

Key words: tilt table, urinary functions.

I. INTRODUCTION

Urination is a vital human bodily function that removes metabolic products and toxic wastes filtered from the kidneys. The process of urinating is regulated by a complex network of signals between the nervous system and the urinary tract.

Neurological damages from stroke, traumatic brain injury or spinal cord injury can cause

complications such as paralysis, cognitive disorders, sensory disorders, and urinary disorders (urinary incontinence, urinary retention or urge to urinate...). Patients with severe neurological damages also get high risk of complications due to prolonged immobility such as pneumonia, pressure ulcer, urinary tract infection related to urinary catheter or residual urine in the bladder...

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Tilt tables are commonly used in intensive care and rehabilitation settings as a technique to reintroduce patients to the vertical position, which conforms naturally human anatomy and physiology. Tilt tables minimize the adverse effects of prolonged immobilization and promote better recovery by increasing lung volumes and lower limb muscle strength, improving cognitive, respiratory, and circulatory functions, and reducing the risk of hospital acquired infection. Tilt tables have been widely used in rehabilitation for Intensive Care Unit patients in countries such as Australia, England....

Tilt tables have been used in Intensive Care Unit and Stroke Center - Military Institute of Traditional Medicine since April 2024. They showed effectiveness in improving respiratory function. However, there has been no evaluation of effectiveness of tilt table on urinary system of these patients. The research question is whether the use of tilt table to support paralyzed patients can help improve urinary function? Therefore, we conducted the study with the objective of "Evaluate the effectiveness of tilt table on improvement of urinary functions and prevention of urinary tract infection in paralyzed patients".

II. METHODS

2.1. Subjects

20 inpatients in the Intensive Care Unit and Stroke Center - Military Institute of Traditional Medicine from September 2024 to October 2024, met the selection criteria.

2.1.1. *Inclusion criteria*

- 18 to 80 of age
- Patients with hemiplegia or quadriplegia who could not stand by themselves.
- Patients had voluntary urination or urinary catheter.

2.1.2. *Exclusion criteria*

- Patients in life threatening conditions that must be immobilized such as moderate to severe stroke, severe traumatic brain injury, gastrointestinal bleeding, acute myocardial infarction...
- Patients had UTI (Fever $>38^{\circ}\text{C}$), frequent urination, urgent urination, pain or burning while urinate, bloody urine or cloudy urine; neutrophil left shift in complete blood count test and presence of nitrite in the urine test.
- Patients or relatives did not consent to participate in research.

2.2. Methods

2.2.1. *Evaluate the ability of emptying the bladder in supine and vertical position.*

- 10 patients with urinary catheter:
- Drained all existing urine in bladder and urine bag. Entered 200ml of 0.9% NaCl into the

bladder then collected output volume.

- 10 patients with voluntary urinary:

After urinating, drunk 500ml of water then performed uroflowmetry test. Collected data included Qmax, Qave, urine output volume. Performed ultrasound to measure residual urine volume.

Patients in both groups performed these procedures in supine position and vertical position (on tilt table).

2.2.2. Evaluate the impact of position on prevention of urinary tract infection

10 patients with voluntary urination were randomly divided into 2 groups:

- Group 1 (5 patients): Patients urinated in vertical position (on tilt table) every time.

- Group 2 (5 patients): Patients urinated in supine position every time.

Patients were assessed for clinical characteristics (fever, frequent urination, urgency, burning urination, cloudy urine, hematuria) and laboratory characteristics (complete blood count test, urinalysis test) before and after 14 days of monitoring.



Table 1. Patient on vertical position with support of tilt table.

2.3. Statistical analysis

SPSS version 22.0 was used for data analysis. Data were described with frequency, percentage, mean and standard deviation. The relation among variables were analyzed by Chi- square

test, T-test, and Paired Samples T-test. The differences were statistically significant when $p < 0.05$.

III. RESULTS

3.1. Characteristics of enrolled patients

Table 1. Characteristics of enrolled patients

Characteristics		Patients with urinary catheter (n=10)		Patient with voluntary urination (n=10)		P
		Frequent	%	Frequent	%	
Age	< 60	5	50	6	60	>0.05
	≥ 60	5	50	4	50	
	($\bar{X} \pm SD$)	49.8 ± 21.1		56.6 ± 16.3		>0.05
Gender	Male	6	60	7	70	>0.05
	Female	4	40	3	30	
Cause of paralysis	Stroke	4	40	7	70	>0.05
	Traumatic brain injury	3	30	2	20	
	Spinal cord injury	3	30	1	10	

Comment: There was no statistically significant difference in age, gender, and cause of paralysis between 2 study groups. Patients with urinary catheter had a higher degree of upper limb paralysis than

patients with voluntary urination ($p < 0.05$).

3.2. The ability of draining the bladder in patients with urinary catheter

Table 2. The ability of draining the bladder in patients with urinary catheter

Index	Supine position (n=10)	Vertical position (n=10)	p
Urine volume (ml)	151.0±30.7	189.5±33.7	<0.05

Comment: With the same 200ml of 0.9% NaCl 200ml entered the bladder, the collected urine volume when patients in vertical

position were more than when patients in the supine position. The difference is statistically significant with $p < 0.05$.

Table 3. The ability of releasing of urine from the bladder in patients with voluntary urination

Index	Supine position (n=10)	Vertical position (n=10)	p
Maximum flow Qmax (mL/s)	9.9 ± 5.7	13.9 ± 5.4	<0.05
Average flow rate Qave (mL/s)	7.3 ± 5.2	11.5 ± 5.3	<0.05
Urine output volume (ml)	163.0 ± 92.7	226.0 ± 94.4	<0.05
Post-void residual PVR (mL)	162.0 ± 79.5	107.0 ± 60.9	<0.05

Comment: The Qmax, Qave and urine output volume were higher and the PVR were lower when patients in vertical position compared with patients in supine

position. The difference is statistically significant with $p < 0.05$.

3.3. The effect of urination position on the risk of urinary tract infection

Table 4. Clinical characteristics after 2 weeks of urinary tract infection assessment

Clinical characteristics	Group 1 (n=10)		Group 2 (n=10)	
	Before	2 weeks later	Before	2 weeks later
Fever ($>38^{\circ}\text{C}$)	0 (0%)	0 (0%)	0 (0%)	1 (20%)
Frequent urination	0 (0%)	0 (0%)	0 (0%)	2 (40%)
Urgent urination	0 (0%)	0 (0%)	0 (0%)	2 (40%)
Pain or burning while urinating	0 (0%)	0 (0%)	0 (0%)	2 (40%)
Bloody urine	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Cloudy urine	0 (0%)	0 (0%)	0 (0%)	0 (0%)

Comment: After 2 weeks of UTI assessment, there were 2 patients in the group of patients urinated in supine position had UTI symptoms (1 patients had fever

$>38^{\circ}\text{C}$) while no patients in the group of patients urinated in vertical position had UTI symptoms.

Table 5. Laboratory characteristics after 2 weeks of urinary tract infection assessment

Laboratory characteristics	Group 1 (n=5)		Group 2 (n=5)		p
	Before ⁽¹⁾	2 weeks later ⁽²⁾	Before ⁽³⁾	2 weeks later ⁽⁴⁾	
<i>Complete blood count test</i>					
Leukocytes (G/L)	6.36±1.43	6.49±1.85	6.13±1.89	7.84±2.46	p ₁₋₂ >0,05 p ₁₋₃ >0,05 p ₂₋₄ >0,05 p ₃₋₄ >0,05
Percentage of neutrophil (%)	56.4±7,80	60.8±5.30	58.9±8.06	70.12±14.92	p ₁₋₂ >0,05 p ₁₋₃ >0,05 p ₂₋₄ >0,05 p ₃₋₄ >0,05
<i>A urinalysis test</i>					
Leukocyturia	0 (0%)	0 (0%)	0 (0%)	2 (40%)	-
Nitrituria	0 (0%)	0 (0%)	0 (0%)	2 (40%)	-
Hematuria	0 (0%)	0 (0%)	0 (0%)	1 (20%)	-
Proteinuria	0 (0%)	0 (0%)	0 (0%)	1 (20%)	-

Comment: After 2 weeks of assessment, the number of leukocytes and percentage of neutrophil in group of patients urinated in supine position tended to increase. However, the difference was not statistically significant ($p>0.05$).

In group of patients urinated in supine position, there were 2 patients with leukocyturia and nitrituria. Of which, 1 patient had hematuria and 1 patient had proteinuria.

There was no abnormal laboratory characteristics in group of patients urinated in vertical position.

IV. DISCUSSION

Neurological damages from stroke, traumatic brain injury or spinal cord injury can impair urinary function.

Patients may have conditions of complete urinary retention that requiring catheterization to drain urine or inability to completely empty the bladder that the bladder always retain a certain amount of urine. The presence or residual urine provides an environment for bacteria to remain in the bladder for a longer period and multiply, potentially cause urinary tract infections. If bacteria move upstream, it may cause nephritis and kidney failure.

The result in Table 2 showed that the ability of draining the bladder through urinary catheter in vertical position was more effective than supine position. With the same volume of NaCl 0.9% entered the bladder, the more urine output

volume collected, the less residual urine volume in the bladder was. It could be explained by the fact that the urine is concentrated at the bottom of the bladder due to the effect of gravity in vertical position. Therefore, it was easier to drain urine out through the catheter.

For patients with voluntary urination, indicators of urinary function measured by uroflowmetry in vertical position were significantly better than supine position. The reason for this difference was in vertical position, the levator ani (LA) muscle moves downward and backward followed by descent of the bladder neck, making it easier for the patient to urinate. A study of Kimihiro et al⁷ on healthy male subjects also showed that urination was more efficient in upright position than in supine position, as expressed by higher average rate of bladder emptying and by fewer participants showing significant residual urine.

In addition, after 2 weeks of UTI assessment, there were 2 patients in group of urinating in supine position had symptoms of UTI with frequent urination, urgent urination and burning sensation, 1 patient also had fever. The result from complete blood count test and urinalysis test also confirmed the diagnosis of UTI with the presence of leukocyturia and nitrituria. Although the number of leukocytes and the

percentage of neutrophils increased in the group of urinating in supine position, the difference was not statistically significant when compared with the group of urinating in vertical position due to the small sample size.

According to Vietnamese Traditional Medicine, “Opening the upper, clearing the lower” is a specific method of treating difficult urination. Ancient physicians used the image of a teapot to illustrate this method. There is a tiny hole on the cap of every teapot. If the hole is blocked while pouring tea, the tea will be exceedingly difficult to pour out. If the hole is clear, the tea will be easy to pour out. Based on this principle, the Lung is in higher position, is likened to the cap of the teapot. The Bladder is in lower position, is likened to the teapot containing the water. If the Lung Qi is not properly distributed, it will affect the Bladder's function of excreting urine.⁸ Therefore, the Lung must be in higher, and the Bladder must be in lower to perform their inherent functions. In paralyzed patients, the Lung and Bladder is in same level that leading inability to perform their function. Tilt table helps paralyzed patients to stand in physical position with the Lungs above and the Bladder below, which is convenient for urination. This helps explain why our research patients in vertical position had

better urination indicators than in supine position.

V. CONCLUSION

Tilt table showed initial effectiveness in improving urinary functions, reducing the residual urine volume, and preventing of urinary tract infection in paralyzed patients. However, further studies with larger sample sizes and longer follow-up are necessary.

VI. RECOMMENDATION

Continue to use the tilt table in rehabilitation of urinary function for paralyzed patients. Continue to evaluate the effectiveness of tilt table on prevention of urinary tract infection in paralyzed patients particularly and patients that require immobilization or being restricted mobility in generally.

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