

1 **Title Page**

2 **Title: Urinate in the Standing Position: a Feasible Alternative for Elderly Woman**
3 **with Knee Osteoarthritis**

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20 **Abstract**

21 **Background:** Elderly women with knee osteoarthritis (OA) have difficulty to micturate
22 when a sitting toilet is not available. The urodynamic data in elderly woman voiding in
23 the standing position had been insufficient.

24 **Objective:** To evaluate the uroflowmetric characteristics and post-void residual urine
25 volume in elderly women with knee OA in the standing position.

26 **Design, Setting, and Participants:** A cross-sectional study involved 21 women (mean
27 age 65.0 ± 4.6). All had a Lequesne index score for knee OA of at least 6 points and were
28 unable to maintain a squat or crouch posture for 20 seconds, and/or difficult to stand from
29 the squatting or crouching position

30 **Intervention:** Participants used a homemade auxiliary appliance to collect urine and
31 drain forward while stand-voiding. Uroflowmetric studies were performed in the sitting
32 and standing positions for two and three attempts, respectively.

33 **Measurements:** The uroflowmetric data, including voided volume (VV), maximal flow
34 rate (Q_{max}), and average flow rate (Q_{ave}) were recorded. The participants completed a
35 questionnaire evaluating their attitude toward stand-voiding and using the auxiliary
36 device.

37 **Results and Limitations:** The Q_{max}, Q_{ave}, VV and PVR obtained in the sitting and
38 standing positions were not statistically different. No "learning curve" was noted for
39 stand-voiding. The patterns of uroflowmetry in the standing position were smooth,
40 suggesting that the opening of the bladder was fully relaxed. Eighty-one percent (17/21)
41 of the subjects experienced no difficulties in stand-voiding. All the subjects expressed
42 their willingness to use the standing position for urination if they did not have access to a

43 satisfactorily clean toilet seat. The limitation of this study is that women with pelvic
44 organ prolapse were not included.

45

46 **Conclusions:** Urinating in the standing position is a feasible option for elderly women
47 with knee OA who have difficulty in crouching or squatting for voiding in public
48 restrooms.

49

50

51 **Introduction**

52 Osteoarthritis (OA) of the knee is one of the most prevalent conditions affecting
53 elderly people [ref 1]. This knee problem makes it difficult or impossible for the elderly
54 to perform tasks, such as climbing stairs, squatting, and crouching [ref 2, ref 3]. The
55 elderly's inability to squat or crouch may have a negative impact on urination. Although a
56 man usually voids in the sitting position, a pedestal or sitting toilet is not always available.
57 In many non-Western societies, the majority of public toilets are the squat types [ref 4, ref
58 5, ref 6]. Even if a sitting toilet is accessible, a woman may still be forced to urinate in a
59 squatting or crouching position if the toilet seat is unsanitary [ref 7]. However, the
60 crouching and squatting positions for voiding are poorly tolerated by women with knee
61 OA. This inconvenience restricts them from going to places where suitable toilets are not
62 within reach, and poses significant impact on their quality of life. Voiding in the standing
63 position using auxiliary devices may be an alternative way for these women to urinate in
64 case there is no reasonably clean pedestal toilet available. Voiding position affects the
65 post-void residual volume and uroflometric findings in men [ref 8]. Our previous study
66 [ref 9] showed no difference in post-void residual volume between the standing and
67 sitting voiding positions among healthy young women. However, to the best of our
68 knowledge, there has been no research on the urodynamics of elderly women with knee
69 OA voiding in the standing position.

70 The aims of this study are as follows: 1). to investigate the uroflometric
71 characteristics and the post-void residual urine volume in elderly women with knee OA in
72 the standing position assisted by a homemade auxiliary device, and 2) to determine the
73 acceptance level of these elderly women to stand-voiding. We hypothesize that urinating

74 in the standing position is a useful alternative for elderly women who have difficulty
75 urinating in the crouching or squatting position because of knee OA.

76

77 **Materials and Methods**

78 We conducted this cross-sectional study to investigate the differences between the
79 uroflometric findings and the post void residual volume in the sitting and standing
80 positions among elderly women with knee OA. All the volunteers met the following
81 criteria: 1) with knee OA and a Lequesne index score for knee OA [ref 10] of at least 6
82 points, 2) unable to maintain a squat or crouch posture for 20 seconds, and/or difficult to
83 stand from the squatting or crouching position, 3) no significant lower urinary tract
84 symptoms, with an American Urological Association (AUA) symptom score [ref 11]
85 below 7. Those with a history of congenital urological disease, interstitial cystitis, pelvic
86 organ prolapse or lower urinary tract symptoms were excluded. Clinical information,
87 including symptoms of knee OA, Lequesne index score, and AUA symptom score, was
88 collected by directly interviewing the participants.

89 To help collect urine and drain it forward into a collecting device, for example, a
90 toilet or a uroflowmeter, we designed a homemade auxiliary device was made from a
91 piece of waterproof paper. The piece of paper was rolled into a horn, with the edge of the
92 wider end folded to prevent errant urine flow. The method of making this device is
93 illustrated in Fig. 1. To void in the standing position, the participant was instructed to
94 place the wider end of the device to cover the perineal area and direct the narrow end of
95 the horn to a collecting device. We let each participant bring one auxiliary device home
96 and make up to two attempts of stand-voiding to get familiar with the device.

97 Uroflometric studies were then performed in the sitting and standing positions for two
98 and three attempts, respectively. If the voided volume (VV) was less than 150 ml, the
99 participant would be asked to repeat voiding in that position. The uroflometric data,
100 including VV, maximal flow rate (Q_{max}), and average flow rate (Q_{ave}), were recorded.
101 Post-void residual urine (PVR) volumes were detected immediately after the participants
102 completed voiding using a sonographic bladder scanner (Bladder Scan, Verathon Inc.)

103 After finishing all uroflometric studies, the participants completed a questionnaire to
104 evaluate their attitude toward stand-voiding and using the auxiliary device. The questions
105 inquired any difficulty experienced while voiding in the standing position, the
106 participants' willingness to try to stand-void after finishing this study, if they were
107 satisfied with the experience of stand-voiding, and if they would recommend this method
108 of voiding to their friends or relatives who have similar knee problems.

109 The study protocol was approved by the Institutional Review Board of our hospital,
110 and all the volunteers gave written informed consent.

111

112 **Data Analysis**

113 Microsoft Access 97 and Statistical Package for the Social Sciences 13.0 were used
114 for data collection and statistical analysis. We presented all continuous variables as the
115 mean \pm standard deviation. Categorical variables were analyzed using the Chi-Square
116 Test and Fisher's Exact Test. We calculated the mean Q_{max}, Q_{ave}, VV, and PVR obtained
117 in the sitting and standing positions for each subject, and then used paired t-test or
118 Wilcoxon signed-rank test for comparison. Analysis of variance (ANOVA) and
119 Friedman's test were used to compare the urodynamic data between different voiding

120 attempts in the standing position. The level of statistical significance was set to $p < 0.05$.

121

122 **Results**

123 Twenty-six women with knee OA were recruited for this study. One subject was
124 excluded because she had PVRs consistently greater than 300 ml. Another four did not
125 complete all the urodynamic examinations. The remaining 21 women were between 60
126 and 75 (mean 65.0 ± 4.6) years old. Their average AUA symptom score and Lequesne
127 index for knee OA were 1.0 ± 0.6 and 8.3 ± 3.1 , respectively. All patients had at least a
128 mild difficulty in squatting or in maintaining the crouching position.

129 The Q_{max} , Q_{ave} , VV and PVR obtained in the sitting and standing positions were
130 not statistically different (Fig. 2). The Q_{max}/Q_{ave} were $23.0 \pm 6.6/11.2 \pm 3.7$ ml/sec in
131 the sitting position and $23.3 \pm 5.4/10.1 \pm 3.5$ ml/sec in the standing position (paired t test:
132 $p=0.89$ for Q_{max} and 0.22 for Q_{ave}). VV and PVR volume were $297 \pm 82/13 \pm 17$ ml in
133 the sitting position and $315 \pm 72/17 \pm 18$ ml in the standing position (paired t-test for VV,
134 $p=0.38$; Wilcoxon signed-rank test for PVR, $p=0.17$). No "learning curve" for voiding in
135 the standing position was noted because the Q_{max} , Q_{ave} , VV, and PVR did not differ
136 among the three measurements (Fig. 3). The patterns of uroflowmetry for all the voiding
137 attempts in the standing position were reviewed by a urologist whose specialty is
138 urodynamics (the first author). The uroflow curves were smooth, suggesting that the
139 opening of the bladder was fully relaxed without resistance while the volunteers were
140 stand-voiding.

141 The questionnaire revealed that 81% (17/21) of the subjects experienced no
142 difficulties in voiding while standing. Four (19%) subjects reported problems, including

143 wet clothes (three incidents) and errant urine (three incidents). Ninety-five percent (20/21)
144 of the subjects were satisfied with the experience using our homemade auxiliary device.
145 All the subjects expressed their willingness to use the standing position for urination if
146 they did not have access to a satisfactorily clean toilet seat, and all were willing to
147 recommend using the homemade auxiliary device for voiding to their relatives and
148 friends who have similar problems in the knees.

149 **Discussion**

150 The present study showed that, utilizing the homemade auxiliary device designed by
151 the authors, elderly women who had difficulty in squatting or crouching because of knee
152 OA could void in the standing position easily, producing Qmax, Qave and PVR not
153 different from those obtained in the sitting position. For women with knee OA, the
154 crouching and squatting positions for voiding are poorly tolerated because of their knee
155 problems. A study conducted by Moore et al. [ref 7] showed that up to 85% of women
156 prefer to void while crouching when using a public restroom, usually because of
157 unsanitary toilets. However, urinating in the crouching position requires a steady crouch
158 posture maintained for over 20 seconds. This is physically difficult or impossible for
159 elderly women with knee OA because of the pain produced in the knees. Moreover,
160 maintaining the crouching position also poses the risk of an accidental fall for elderly
161 women. Many public toilets in non-Western societies are squat types [ref 4, ref 5, ref 6].
162 This is obviously a problem for women with knee OA because difficulty in squatting is
163 one of most common functional limitations caused by knee OA [ref 5, ref 6]. Even if they
164 manage to squat successfully, standing up again is often difficult for them. Voiding in the
165 crouching position over a squat toilet is also problematic because the distance between

166 the opening of the urethra and the squat toilet is so great that urine may spray over a wide
167 range and stain their clothes. As a result, they might choose to hold their urine until they
168 arrive home. Urinary tract infections, voiding dysfunctions, and chronic retention have
169 been associated with such micturition behaviors [ref 12]. The movements of these women
170 will thus be confined to where there is access to reasonably clean sitting toilets. We
171 believe that our homemade auxiliary device is very helpful for any woman with knee
172 problems to void in the standing position in case there is no acceptably clean pedestal
173 toilet nearby. The vast majority (81%) of our subjects experienced no difficulties voiding
174 in the standing position using our auxiliary device. Although four subjects did report
175 some problems including wet clothes and errant urine, all but one of the 21 subjects were
176 satisfied with the experience of voiding in the standing position. All subjects were also
177 willing to try to void in the standing position when a clean public toilet seat is not
178 available in the future. These results supported our hypothesis: urinating in the standing
179 position is an acceptable alternative for elderly women who have difficulty in crouching
180 or squatting because of their knee problems.

181 Previous studies showed that women could urinate in the standing position with the
182 help of auxiliary appliances [ref 9, ref 13]. However, these studies were all based on
183 younger participants (age < 50). The present study is the first to include elderly women
184 (average 65.0 years) with knee OA. One of our previous studies [ref 9] showed no
185 apparent learning curve for healthy young women to void in the standing position using
186 our prototype homemade auxiliary device. In the present study, we gave each volunteer
187 one auxiliary device to let her practice voiding in the standing position at home for up to
188 two attempts prior to undergoing the urodynamic studies. Thus the three stand-voiding

189 uroflowmetric measurements were actually a participant's third to fifth attempts in using
190 the device. Nonetheless, because the urodynamic results measured were similar for the
191 three stand-voiding attempts were similar, we concluded that that the subjects in this
192 study showed no obvious problems in learning how to use the auxiliary device properly.

193 In this study, a homemade auxiliary device was used to help our subjects urinate
194 while standing. There are commercialized devices available in the market, but these
195 devices are relatively expensive and not readily purchasable in many countries.
196 Following our instructions, our subjects were able to make the auxiliary device by
197 themselves within three minutes, provided that a piece of proper waterproof paper (an
198 ordinary magazine cover would suffice) and scissors were at hand. This auxiliary device,
199 which is self-made and can be put in a ladies' handbag, enables elderly women to go out
200 without being afraid that there is no desirable toilet available.

201 Subjects with pelvic organ prolapse, which has a significant impact on micturation
202 in the sitting or squatting position, were not included in the study. Pelvic organ prolapse
203 is related with outlet obstruction and symptoms of voiding difficulty [ref 14]. Because the
204 prolapse of pelvic organ tends to be less prominent while a patient is standing, we believe
205 that voiding in a standing position might be beneficial for those subjects. Further study
206 investigating micturition in the standing position in women with pelvic organ prolapse is
207 thus needed.

208 **Conclusions**

209 Urinating in the standing position is a good option for elderly women with knee OA
210 who have difficulty in crouching or squatting. Using the homemade auxiliary device
211 designed by the authors, they can produce Qmax, Qave, VV, and PVR similar to those

212 obtained in the sitting position.

213

214 Figure Legends

215 Fig 1. Steps in making the auxiliary device.

216 Fig 2. Urodynamic results obtained in the sitting and standing positions. Qmax: maximal

217 flow rate; Qave: average flow rate; A: paired t-test, p=0.89; B: paired t-test, p=0.22; C:

218 paired t-test, p=0.38; D: Wilcoxon signed-rank test, p=0.17

219 Fig. 3. Urodynamic results obtained from three attempts of stand-voiding. Qmax:

220 maximal flow rate, Qave: average flow rate; A: ANOVA, p=0.95; B: ANOVA, p=0.30; C:

221 ANOVA, p=0.34; D: Friedman test, p=0.68

222

223

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