



Comparing the efficacy of the Knack maneuver on pelvic floor muscle function and urinary symptoms using different teaching methods: a prospective, nonrandomized study

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Abstract

Introduction and hypothesis This study was aimed at comparing the efficacy of Knack maneuver training taught using different techniques on pelvic floor muscle (PFM) function, urinary symptoms, and perception of improvement in women with stress urinary incontinence (SUI).

Methods We conducted a prospective nonrandomized study of 46 women with SUI. Assessments included: PFM functions (secondary outcome, SO) using a Myomed 932 EMG biofeedback device, urinary incontinence symptoms using the International Consultation on Incontinence Questionnaire Urinary Incontinence-Short Form (ICIQ-SF; primary outcome), the Urogenital Distress Inventory-6 (UDI-6; SO), and the Incontinence Severity Index (ISI; SO), and perception of improvement using the Global Perceived Impact scale. The women were divided into three groups according to their preference: group 1 (Knack maneuver training with electromyography biofeedback), group 2 (Knack maneuver training with verbal instruction), and group 3 (Knack maneuver training with vaginal palpation). An education program was also given to all women individually. The training program was 1 day per week for 4 weeks.

Results There was an improvement in UDI-6, ICIQ-SF, and ISI scores in all groups ($p < 0.05$). The maximum voluntary contraction (MVC) of the PFM increased in group 2 ($p = 0.002$), whereas both the MVC of PFM and PFM contraction during Valsalva increased in group 3 ($p = 0.011$ and $p = 0.042$).

Conclusions Regardless of the teaching methods, the Knack maneuver and education programs were effective on urinary symptoms in women with mild to moderate SUI. The Knack maneuver training with vaginal palpation and verbal instruction improved MVC of PFM. All three different teaching methods might be used in SUI treatment programs.

Keywords Knack maneuver · Patient education · Stress urinary incontinence · Valsalva maneuver

Introduction

Stress urinary incontinence (SUI) is the complaint of involuntary loss of urine on effort or physical exertion, including sporting activities, or on sneezing or coughing, according to

the International Continence Association [1]. An automatic response, an involuntary pelvic floor muscle (PFM) contraction, occurs before or during physical exertion in healthy continent women [2]. This PFM motor reaction occurs when coughing or sneezing is a rapid feed-forward cycle [3]. It occurs 210–270 ms before the intra-abdominal pressure (IAP) increases and keeps the urethral pressure higher than the intravesical pressure during physical exertion. It has been reported that this phenomenon may have disappeared in women with SUI [2, 4].

It is thought that the Knack maneuver with PFM pre-contraction may be an effective and rapid technique in the formation of insufficient pre-contraction in women with SUI. The effects of the Knack maneuver are based on anatomical and biomechanical foundations [5, 6]. Anatomically, the urethral support structures (levator ani) and the urethra (external

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urethral sphincter component) are composed of voluntary striated muscles. Active contraction of these muscles temporarily increases both the stiffness of the supporting structure of the urethra and the pressure within the urethra to prevent urine outflow [5, 7]. Miller et al. reported that the Knack maneuver during moderate and deep coughing reduced urine loss by 98.2% and 73.3% respectively [8]. This maneuver provides significant reductions in urine leakage within a short period of 1 week, which is too early to be accepted owing to PFM strength increase and hypertrophy and is expressed as rapid therapy that does not include special muscle strengthening exercises [9]. In addition, just as it is possible to learn to bring our hand to our mouth before and during coughing, it is thought that it is possible to learn PFM contraction before single and simple situations that increase IAP, such as coughing or abdominal exercise [10]. Knack maneuver training is based on the motor relearning principles of PFMs [11]. Active contraction of the levator ani and external urethral sphincter due to motor relearning of the Knack maneuver temporarily increases the stiffness in the supporting structure of the urethra [5] and the pressure inside the urethra [7] to prevent urine outflow. Thanks to these mechanical bases, when women are taught to contract their PFMs in the case of sudden UI, it is reasonable to assume that the resulting improvement in urethral closure pressure will rapidly reduce urine leakage.

The Knack maneuver has generally been included in treatment concepts as a part of PFM training, which has limited the determination of the effectiveness of the isolated Knack maneuver on SUI [12–14]. In addition, practical differences in teaching this maneuver modify its effectiveness on PFM function and UI symptoms. De Andrade et al. reported that the maximum voluntary contraction (MVC) of PFMs and urinary symptoms did not change after four weeks of training consisted of the Knack maneuver with the education program and verbal instruction [15]. However, Miller et al. reported that urinary symptoms of women improved after 1 week's training consisting of the Knack maneuver with vaginal palpation [8]. The effectiveness of the Knack maneuver, which is taught using different techniques in the literature, on urinary symptoms is controversial. Therefore, in our study, women with SUI were given isolated Knack maneuver training with different feedbacks (auditory, visual, tactile) by following the motor learning steps defined for the PFMs. This study was aimed at comparing the efficacy of Knack maneuver training taught using different techniques on PFM function, urinary symptoms, and perception of improvement in women with SUI.

Materials and methods

Participants

The study included 54 women with SUI or stress-predominant mixed urinary incontinence (MUI) whom an obstetrician or gynecologist had referred. Among the 54 women referred to as having SUI, those with pelvic organ prolapse stage 2 who declined to participate were excluded, and the study began with 49 women.

Inclusion criteria were participating in the study voluntarily, being able to read and write in Turkish, not having any mental problems that prevent cooperation and understanding, and having mild/moderate SUI or stress-dominant MUI. Women who had had previous pelvic floor training, had a neurological disease, had stage 2 or higher of the pelvic organ prolapse stage, had fecal incontinence, were pregnant, had lower extremity inequality, or had a bilateral hip prosthesis were excluded from the study.

Ethical approval for this study was obtained from Abant İzzet Baysal University Ethics Committee (approval number: 2020/42). All participants provided written informed consent according to the principles stated in the Declaration of Helsinki.

Sample size

We used the G*Power software program (Version 3.0.10; Heinrich-Heine Universität, Düsseldorf, Germany) to determine the necessary sample size for this study. As there was no similar study in literature, the sample size was determined by a pilot study of 17 women. In the pilot study, a large effect size ($f=0.883$) was found between the three groups in terms of ICIQ-SF values. With this effect size, we planned to recruit a total of at least 27 women, at least 9 in each group, giving a statistical power of 80% ($\alpha=5\%$). Owing to an expected dropout rate of 25%, we planned to recruit at least 36 women (12 per group) into the study.

Interventions

The women were divided into three groups: group 1 ($n=17$)—Knack maneuver training with electromyography (EMG) biofeedback; group 2 ($n=17$)—Knack maneuver training with verbal instruction; group 3 ($n=15$)—Knack maneuver training with vaginal palpation. Women were grouped as nonrandomized. This study was conducted during the pandemic (especially the initial period). Therefore, some women did not want to be in the contact group. In addition, some women did not want to be in the group that included vaginal intervention. For this reason, while forming

the groups of the study, it was taken into account which group the women wanted to be in. Originally, the study was designed as a randomized study, but it was changed as described above because of women's reluctance to undergo randomization. All women were included in the training program individually by a specialist physiotherapist (SYY), who has 8 years of experience in physiotherapy and rehabilitation in pelvic floor dysfunction, once a week for 4 weeks. Each training program (15 min of education + 15 min of Knack maneuver training) lasted 30 min.

Education program

Within the scope of the education program, pelvic floor anatomy, function, dysfunction, SUI definition, risk factors, and treatment options were explained using four different education materials. Women participated in the education program in the clinic with one education material in each session. The education program lasted 15 min. In the first session a PowerPoint presentation, in the second session a pelvis model, in the third session pelvic floor visualization, and in the fourth session a brochure created by the authors were used. The same education program was given to the women in all three groups individually.

Knack maneuver training

General procedure

Diaphragmatic breathing was demonstrated to all women before each session of the Knack maneuver. During Knack training, women were warned not to hold their breath, pull their stomach inward, strain, or contract their legs or hip muscles. The relationship between IAP increase and PFM contraction and the situations causing IAP increase (coughing, sneezing, laughing, lifting a heavy object, pushing, and bending down, etc.) were explained. The women were asked to perform the Knack maneuver before and during situations that increase intra-abdominal pressure. In addition, the women noted on the Knack maneuver follow-up chart the activities that increase IAP during the day and the Knack maneuvers they could do during the day. The Knack maneuver was taught to women according to motor learning phases [11]:

1. Understanding phase: before the Knack maneuver training, all women were given information about the PFM structure and function, and the SUI mechanism.
2. Search phase: the answer to the question "Where is my pelvic floor" on their bodies was shown to the women using the education program and different feedbacks. The feedback was the EMG probe in group 1, the ver-

bal instruction in group 2, and the vaginal palpation in group 3.

3. Finding phase: the location of the PFMs in the body was found with the education program and different training methods by women. The PFMs were found with the education program and EMG biofeedback in group 1, the education program and verbal instruction in group 2, and the education program and vaginal palpation in group 3.
4. Learning phase: correct PFM contraction was taught using different feedback after the women had found the PFMs. The types of feedback were auditory, visual, and tactile in group 1, auditory in group 2, and auditory and tactile in group 3.
5. Control phase: the women integrated the Knack maneuver into functional activities with the Knack maneuver follow-up chart after learning the correct PFM contraction.

Interventions

Group 1: teaching the Knack maneuver using the EMG biofeedback The EMG probe (Myomed 932®-Enraf-Nonius, Delft, The Netherlands) was placed intravaginally while supine, with knees bent and slightly apart. Before the training, the device was sterilized, and a separate EMG probe was used for each individual. The probe was placed in the vagina using sufficient lubricant gel, and the reference electrode was placed on the arm. The appropriate threshold value was set for the individual by taking the resting EMG value as a reference. The volume value was fixed at 100 units. While the woman performed a PFM contraction in the contraction portion of the graph, it was accompanied by audio feedback of the device. In addition, the device's screen was positioned so that the woman could see it. For slow contractions of the PFMs, the contraction time of the device was set as 5 s and the relaxation time as 10 s. The woman was asked to squeeze and pull the probe inward, maintain this position for the contraction duration, and then relax for 10 s. For fast contractions of the PFMs, the device was set to continuous mode, and training was given with the command to squeeze-pull-release the probe by following the graph.

Group 2: teaching the Knack maneuver with verbal instruction In the training procedure, the woman was lying on her left side with her knees bent, and her head and the upper leg were supported by a pillow. For fast contractions of PFMs, the analogy of "tap on-off" was used. For slow contractions of the PFMs, the analogy "the elevator goes up and down slowly" was made. The elevator was asked to go up for 5 s and down for 10 s.

Group 3: teaching the Knack maneuver with vaginal palpation While the woman was supine, with knees bent and slightly apart, the physiotherapist (PT) placed her index and middle fingers intravaginally after necessary hygiene measures were taken. For slow contractions of the PFM, the woman was asked to squeeze the PT's fingers as if holding her urine or stool and to continue this position for 5 s. For PFM relaxation, the instruction was given to "stop squeezing and pulling the PT's fingers upward and maintain the relaxation in your PFM for 10 s". For rapid contractions of the PFM, the PT's finger squeeze-pull-relax command was explained.

Outcome measures

Women were assessed twice at baseline and post-training. The subjective perception of improvement was assessed only post-training. After asking for the socio-demographic characteristics of the women, incontinence symptoms and PFM functions were assessed using the UDI-6, ICIQ-SF, ISI, and 932 Myomed biofeedback device (Myomed 932®). The subjective perception of improvement was assessed using the Global Perceived Impact (GPI) scale. All assessments were made by taking COVID-19 pandemic measures.

Primary outcome: International Consultation on Incontinence Questionnaire Urinary Incontinence-Short Form

The women's UI symptoms and the effects on quality of life were measured using the Turkish version of the ICIQ-SF. The scale has four dimensions. In the first dimension, the frequency of UI, in the second dimension the amount of UI, in the third dimension the effect of UI on daily life, and in the fourth dimension the situations that cause UI in the fourth dimension are dealt with. The first three dimensions are scored in the evaluation. The answers given to the fourth dimension, which is not scored, are used to determine the individual's type of UI. The scores that can be obtained from the scale range from 0 to 21; a low score indicates that UI affects the quality of life in a minor way, and a high score indicates that it affects the quality of life in a major way [16].

Secondary outcomes

Pelvic floor muscle functions General procedure Maximum voluntary contraction of PFM and PFM contraction in Valsalva were evaluated using the 932 Myomed biofeedback device. Before the test, the sensitivity value of the device was set as 360 hPa, the threshold value as 0 hPa, and the probe was used with a condom. The pressure probe was inserted intravaginally during the assessment while the woman was in the supine position, with knees bent and

slightly apart. After checking that the probe was placed correctly and appropriately, the PT supported the probe manually during the procedure.

Maximum voluntary contraction For MVC of the PFM, the women were instructed to "Use your PFM to squeeze the probe as much as you can, pulling it up and in." The contraction time of the device was set as 5 s and the relaxation time as 10 s, and they were asked to perform PFM contraction three times [17]. The mean of these three measurements was recorded. The MVC of the PFM was calculated by subtracting the resting value from the maximum value of the PFM contraction. Value MVC of PFM was recorded as hectopascal. During the assessment, the woman was warned not to hold her breath, not to pull her belly in, not to strain, not to contract her legs or hip muscles, and not to move her pelvis.

Pelvic floor muscle contraction during Valsalva Valsalva is defined as a forced maximum expiratory effort against a closed glottis that causes an increase in IAP after maximum inspiration [18]. For the PFM contraction during Valsalva, the women were given the instruction: "Valsalva increases IAP. With this assessment, we evaluate the reflex PFM activity that occurs in situations that cause increased IAP" by the PT. The degree of pressure during Valsalva was not standardized by an objective tool. Standardization was achieved by giving the same instructions as "take a deep breath as much as possible, cover your mouth and nose with your hands and try to breathe out against the closed respiratory system." The contraction activity of the muscles was recorded for 2 s and relaxation activity for 10 s. The assessment was performed for one repetition in order not to increase the cardiac load.

Urinary symptoms Urogenital Distress Inventory-6 The women's UI symptoms were measured using the Turkish version of the UDI-6. The UDI-6 consists of six questions evaluating lower urinary tract symptoms, including UI in women. The grading system is in the form of a four-point Likert scale. The first two questions are for irritative symptoms (urgency, frequency, and pain), the third and fourth questions are for stress symptoms, and the last two questions are for obstructive or voiding symptoms. The UDI-6 test scores are evaluated out of 100 [19].

Incontinence Severity Index The ISI asked questions about the women's incontinence severity. In this index, women were asked two questions: "How often do you experience urinary leakage?"—1 (less than once a month), 2 (a few times a month), 3 (a few times a week), or 4 (every day and/or night) points; and "How much urine do you lose each time?"—1 (drops), 2 (small splashes), or 3 (more) points. Then, the scores of these two questions were added together, and the total score was obtained. The total score ranges from 1 to 12, with a higher score indicating more severe UI. The

ISI also scored 0 for no incontinence when treatments led to no incontinence [20].

Subjective perception of improvement

Women's subjective perception of improvement was assessed using the GPI scale. The woman was asked to rate how much her complaints improved compared with the baseline on a scale from 1 to 9. Interpretation of scores were 1, very much improved; 2, highly improved; 3, moderately improved; 4, slightly improved; 5, unchanged; 6, slightly worse; 7, moderately worse; 8, much worse; and 9, very much worse [21].

Statistical analyses

The data were analyzed using the Statistical Package for the Social Sciences (SPSS version 21.0) software. For descriptive statistics, number and percentage values were given in categorical data type, and mean and standard deviation or median and minimum to maximum values were given in numerical data types. Chi-squared test statistics were used for group comparison for categorical variables. Shapiro–Wilks test was used for the assumption of normality. One-way analysis of variance or Kruskal–Wallis test was used to compare groups. In comparing pre- and post-measurements, *t* test or Wilcoxon test was used in independent groups. Post-hoc tests were used to identify the group(s) that made a difference. A *p* value less than 0.05 was considered evidence for a statistically significant difference.

Results

Forty-nine women with SUI or stress-predominant MUI were included in the study, but 46 of the women completed all the Knack maneuver training sessions. Three women withdrew from the study: 1 of them had COVID-19 contact and 2 of them could not follow the study because of transportation and family problems. Overall and subgroup analyses showed no significant differences in demographic characteristics (except for BMI) or outcome measures between groups at baseline ($p > 0.05$; Tables 1, 2, and 3). There was a significant difference between groups 2 and 3 in BMI ($p = 0.031$; Table 1). Group 2 had a lower BMI, whereas group 3 had the higher values.

Regardless of the teaching methods, ICIQ-SF, UDI-6, and ISI scores of all groups improved significantly after the Knack maneuver training ($p < 0.05$; Table 2).

There were significant differences between the MVC values of the groups after the training ($p = 0.007$). Group 2 improved to a significantly greater degree in MVC of PFM values. In the baseline to post-training change in groups 2 and 3 statistical improvement was found. An increase in

MVC of PFM was observed over time in groups 2 and 3 (Table 3).

There was a significant difference between the values of PFM contraction in Valsalva of the groups after the training ($p < 0.001$). This difference was due to group 1. Group 1 had a lower PFM contraction value in Valsalva than the other groups. In the baseline to post-training change in group 3 statistical improvement was found. In baseline to post-training change analysis, statistical improvement was found in group 3. An increase in PFM contraction value in Valsalva was observed over time in group 3 ($p = 0.042$; Table 3).

The GPI scale scores of the groups post-training and the number of days they performed the Knack maneuver were similar ($p > 0.05$; Table 4).

Discussion

This study was aimed at comparing the efficacy of Knack maneuver training taught using different techniques on PFM function, urinary symptoms, and perception of improvement in women with SUI. The study put forward the following short-term findings at 4 weeks: all three teaching methods of the Knack maneuver training reduced UI symptoms. Knack maneuver training with vaginal palpation improved PFM contraction in Valsalva compared with the other two teaching methods. In addition, Knack maneuver training with vaginal palpation and verbal instruction improved the MVC of PFM in women with SUI.

In our study, UI symptoms and associated quality of life improved in three groups after training, regardless of teaching methods. Considering the amount of improvement of 11 [22] points in UDI-6 scores and 2.5 points in ICIQ-SF scores [23] of all three groups, and these results show that there is a clinically important improvement. Previous studies showed that an education program on pelvic floor health led to a decrease in symptoms and an increase in quality of life in women with UI [24, 25]. The education program that was given in this study may contribute to women's ability to perform the maneuver correctly and thus increase their ability to cope with UI, which is encountered in daily life with increased IAP. In two different studies, it was stated that the amount of UI decreased after training with the Knack maneuver given with both vaginal palpation and verbal instruction techniques in women with SUI and pregnant women [8, 9]. The biological effect of the Knack maneuver in SUI occurs by increasing the urethral closure pressure [7], improving bladder stabilization, and increasing structural support during PFM contraction [5]. Thanks to these mechanical bases, we hypothesize that when women are taught to contract their PFM during sudden UI, there might be a rapid decrease in urine leakage and a decrease in

Table 1 Comparison of the characteristic features of the groups

Characteristics		Groups			<i>p</i>
		Group 1 (<i>n</i> =16)	Group 2 (<i>n</i> =15)	Group 3 (<i>n</i> =15)	
Age (years)		53.88 ± 10.72	50.47 ± 10.20	53.47 ± 7.86	0.575*
BMI (kg/m ²)		29.74, ± 5.24	26.17 ± 3.21	30.11 ± 4.31	0.031*
Education level	Primary school	8 (50.0)	7 (46.7)	9 (60.0)	0.458**
	Middle school	2 (12.5)	1 (6.7)	3 (20.0)	
	High school	2 (12.5)	3 (26.7)	0 (0.0)	
	Graduate	4 (25.0)	4 (26.7)	3 (20.0)	
Occupation ^b	Housewife	13 (81.3)	11 (73.3)	11 (73.3)	0.641**
	Private sector	2 (12.5)	3 (20.0)	3 (20.0)	
	Officer	1 (6.3)	0 (0.0)	0 (0.0)	
	Retired	0 (0.0)	1 (6.7)	1 (6.7)	
Marital status	Married	13 (81.3)	13 (86.7)	13 (86.7)	0.891**
	Single	3 (18.8)	2 (13.3)	2 (13.3)	
Smoking status	Yes	4 (25.0)	2 (13.3)	3 (20.0)	0.254**
	No	9 (56.3)	11 (73.3)	12 (80.0)	
	Give up	3 (18.8)	2 (13.3)	0 (0.0)	
Defecation frequency (in a week)		7 (3–21)	7 (2–25)	10 (2–28)	0.571***
Incontinence duration (years)		2.5 (1–10)	5 (1–18)	3 (1–20)	0.240***
Incontinence during pregnancy	Yes	5 (31.3)	2 (13.3)	2 (13.3)	0.360**
	No	11 (68.8)	13 (86.7)	13 (86.7)	
Menstrual status	Normal, regular	5 (31.3)	3 (20.0)	2 (13.3)	0.700**
	Irregular	2 (12.5)	3 (20.0)	1 (6.7)	
	Menopause spontaneous	8 (50.0)	7 (46.7)	11 (73.3)	
	Menopause surgery	1 (6.3)	2 (13.3)	1 (6.7)	
Obstetrics history	Gravida	3.0 (0.0–11)	4.0 (1.0–6.0)	3.0 (0–11.0)	0.824***
	Para	2.0 (0.0–7.0)	3.0 (0.0–6.0)	2.0 (0.0–5.0)	0.632***
	Miscarriage	0.0 (0.0–2.0)	0.0 (0.0–1.0)	0.0 (0.0–2.0)	0.313***
	Abortion	0.0 (0.0–9.0)	1.0 (0.0–4.0)	0.0 (0.0–8.0)	0.846***
	Alive	2.0 (0.0–7.0)	2.0 (0.0–4.0)	2.0 (0.0–5.0)	0.998

BMI body mass index

*One-way analysis of variance

**Chi-squared test

***Kruskal–Wallis test

Table 2 Comparisons of Urogenital Distress Inventory-6 (UDI-6), Incontinence Severity Index (ISI), and International Consultation on Incontinence Questionnaire Urinary Incontinence-Short Form (ICIQ-SF) scores within and between groups

		Group 1 (<i>n</i> =16)	Group 2 (<i>n</i> =15)	Group 3 (<i>n</i> =15)	<i>p</i> ** (group)
Urinary incontinence symptoms					
UDI-6	Baseline	36.07 (5.5–66.6)	22.2 (5.55–66.6)	27.77(5.5–61.1)	0.252
	Post-training	5.55 (0.0–22.22)	5.55 (0–33.33)	5.55(0–33.33)	0.778
<i>p</i> * (time)		0.001	0.001	0.0013	
ICIQ-SF	Baseline	10 (4–21)	10 (3–13)	8 (4–17)	0.768
	Post-training	4.0 (0–9)	3.0 (0–10)	5.0 (0–14)	0.564
<i>p</i> * (time)		0.001	0.001	0.003	
ISI	Baseline	3.0 (2.0–6.0)	3.0 (1.0–6.0)	4.0 (2.0–6.0)	0.286
	Post-training	1.0 (0.0–4.0)	1.0 (0.0–3.0)	1.0 (0.0–4.0)	0.792
<i>p</i> * (time)		0.003	0.003	0.003	

*Wilcoxon test

**Kruskal–Wallis test

Table 3 Comparison of pelvic floor muscle functions within and between groups

Pelvic floor muscle functions		Group 1 (n=16), mean ± SD	Group 2 (n=15), mean ± SD	Group 3 (n=15), mean ± SD	p** (group)
MVC value of pelvic floor muscle (hPa)	Baseline	31.25 ± 18.69	33.93 ± 16.39	26.47 ± 16.20	0.488
	Post-training	30.27 ± 16.75	48.07 ± 14.64	31.85 ± 16.29	0.007
p* (time)		0.947	0.002	0.011	
Pelvic floor muscle contraction (hPa) in Valsalva	Baseline	17.56 ± 13.15	31.20 ± 19.19	24.07 ± 17.06	0.085
	Post-training	13.47 ± 11.67	35.73 ± 15.04	29.0 ± 15.82	<0.001
p* (time)		0.519	0.405	0.042	

MVC maximum voluntary contraction, SD standard deviation

*One-way analysis of variance

**Dependent t test

Table 4 Comparison of the Groups' Global Perceived Impact scale scores and Knack maneuver follow-up charts

	Group 1 (n=16)	Group 2 (n=15)	Group 3 (n=15)	p*
Global Perceived Impact scale	3 (2–9)	3 (1–6)	4 (1–8)	0.592
Knack maneuver follow-up charts (day)	20 (0–20)	13 (3–20)	20 (5–20)	0.093

*Kruskal–Wallis test

the severity of UI with an improvement in urethral closure pressure.

It has been reported that the improvement in muscle functions before muscle hypertrophy occurs may be related to neuromuscular adaptation. This relationship is explained by better muscle function as more motor units are activated with motor learning [26]. Our study showed that MVC values of PFM improved in women who were taught the Knack maneuver with vaginal palpation and verbal instructions. Verbal instructions during verbal education are based on PFM function knowledge and support learning [11]. Henderson et al. stated that women who could not contract PFM contraction at the initial evaluation were able to contract their PFM correctly after a short verbal instruction and that correct PFM contraction could be taught with verbal instruction [27]. However, De Andrade et al. trained, in groups of 10, incontinent women on an education program on pelvic floor awareness and Knack maneuver training using the verbal instruction method. They stated that only the level of knowledge of the trained group increased, and PFM contraction skill and MVC were similar to the nontrained group [15]. There may be some reasons why it differs from our study. In our study, women participate in the training

individually with the instructions of the PT so that they can understand and apply the imagery correctly.

The literature states that vaginal palpation is necessary to teach the PFM contraction correctly [28]. Also, motor relearning is dependent on sensory feedback, and learning is generally facilitated by using feedback. Vaginal palpation is a proprioceptive stimulus that can be used to support learning and help women perform correct PFM voluntary contractions [11]. In addition, it has been reported that both unidigital and bidigital vaginal palpation is a highly reliable measurement method in teaching MVC of PFM [29]. Our study determined an improvement in PFM contraction in Valsalva in the group in which the Knack maneuver was taught with the bidigital vaginal palpation method after training. Thus, it was determined that the Knack maneuver taught by an experienced PT without using any equipment could be used to treat SUI in isolation or in combination with exercises in PFM training.

The group in which the Knack maneuver was taught with EMG biofeedback made a difference between the groups in terms of PFM contraction in Valsalva post-training. Several reasons may exist for this result. The first reason was the hormonal fluctuation in the menstrual cycle because the number of women whose menstrual cycle continued in this group was higher than in the other groups. Micussi et al. researched the MVC of PFM values throughout the menstrual cycle. It was found that women had higher PFM tone in the luteal phase, and muscle tone and MVC correlated strongly with estradiol level at day 7 [30]. In our study, hormonal fluctuations in the menstrual cycle may have changed the PFM activity of women and are reflected in the assessment results. Second, women in this group may need additional training and time to improve the necessary coordination and skills to perform an effective Knack maneuver. Because the women in the group generally had difficulty creating synchronization by simultaneously contracting the PFM and following the screen image and sound of the device. Performing two activities simultaneously (for example, one cognitive task

and one motor task or two motor tasks) is defined as a dual task. Villot et al. reported that the reaction time of voluntary and involuntary PFM contraction changed with the dual task [31]. The second reason is that auditory, visual, and tactile feedback may not be synchronous with PFM contraction in women in this group.

As far as we know, the number of studies evaluating the effect of the Knack maneuver on the subjective perception of improvement is limited in the literature. In our study, women's subjective perceptions of improvement were generally determined as slightly improved and moderately improved. Miller et al. also reported that 72% of women with incontinence had a self-healing perception after training with the Knack training [32].

There were some limitations to our study. The first was that in this study we could not generate the random allocation sequence as some women did not want to participate in vaginal palpation and contact training owing to the COVID-19 pandemic, although without randomization, in the preliminary evaluation, it was observed that the groups were similar and homogeneous in terms of the outcome measurements of our study. The use of verbal instructions to generate standard IAP values during Valsalva in our study can be considered as another limitation. However, we believe that use of the same verbal instruction with all women by an experienced PT generates a standard IAP value during Valsalva. Our last limitation was that some women did not write the number of maneuvers they performed on the Knack maneuver follow-up charts; thus, the number of maneuvers performed during the day in the two groups could not be compared.

Conclusion

To our knowledge, this is the first prospective nonrandomized study to compare the efficacy of the Knack maneuver on urinary symptoms according to various teaching methods. The Knack maneuver in the treatment of SUI should be taught by experienced physiotherapists in primary health care as a “public health” approach and should be accessible to everyone. Regardless of the teaching methods, Knack maneuver training has a positive effect on urinary symptoms and subjective perception of improvement. It does not require equipment and is practical to use in the clinic. In addition, the practical results of teaching the Knack maneuver with vaginal palpation and verbal instruction techniques can be an alternative to teaching using the EMG biofeedback technique. Giving women an education program at the same time enables them to increase their awareness of the PFMs and to understand better and apply mechanisms to cope with UI during increased IAP in daily life. From this point of

view, adding a detailed education program to the treatment increases its effectiveness.

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Declarations

Conflicts of interest None.

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