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Using an anatomic model to teach female stress incontinence to gynecologic residents-in-training: A prospective cohort study

Lilibeth Lim-Navarro[1], Joanne Karen S. Aguinaldo[1]

Abstract:

BACKGROUND: Stress urinary incontinence (SUI) is a complex condition with a multifactorial etiology that makes its concepts challenging to teach. This study aimed to assess the efficacy of simulation-based training (SBT) with an anatomic teaching model in improving the understanding of SUI among gynecologic residents-in-training.

OBJECTIVE: The primary objective of this study was to evaluate the efficacy of SUI simulation-based teaching in enhancing the learning experience for gynecologic residents-in-training. The secondary objective was to gather feedback from participants with the intent to further enhance existing teaching methodologies.

MATERIALS AND METHODS: This was a descriptive prospective study within a single institution, involving gynecologic residents-in-training. Participants were given an anatomic teaching tool to construct, followed by an SUI lecture. Pre- and posttest Multiple Choice Questions were administered to assess the efficacy of the teaching tool in improving the participants' understanding of SUI. Frequency and percentages were used to describe the categorical variables, whereas continuous variables were described using mean and standard deviation. Paired *t*-test was used to compare the pre- and posttest scores. ANOVA was used to compare the pre- and posttest scores of participants by year level. A $P < 0.05$ is statistically significant. A separate Likert-scale questionnaire, to evaluate changes in participant's self-assessment on learning, response to teaching content and resources, and overall feedback of the SBT was used.

RESULTS: There were 50 gynecologic residents-in-training that were included in the study. The mean posttest score is significantly higher (6.4 vs. 3.48) than the pretest score, with a mean difference of 3.48. The mean posttest score is significantly different between the year levels with a $P < 0.05$, with senior residents-in-training performing best. Although participants with only gynecologic conferences as SUI reference performed best, the mean pre- and posttest scores were not statistically different with respect to SUI education exposure. With the use of an anatomic SUI model, the number of correct answers for questions pertaining to anatomy, physiology, and pathophysiology was consistently higher in the posttest scores as compared to the pretest scores but did not reach statistical significance. The majority of participants strongly agree to recommend the course to a colleague.

CONCLUSION: This study supports the use of simple, low-fidelity physical teaching tools in improving the understanding of SUI in gynecologic residents-in-training. Considering the ease of production, improved test scores, and participants' enthusiasm, the incorporation of the anatomic teaching tool for its use in SUI education should be encouraged.

Keywords:

Anatomic teaching tool, gynecology training, stress urinary incontinence education

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Introduction

Stress urinary incontinence (SUI), as defined by the International Continence Society, is the involuntary leakage of urine on effort or exertion or on sneezing or coughing.[1] SUI is a complex condition with a multifactorial etiology that makes its concepts challenging to teach.

In the Philippines, local studies report 13%–23% of women report symptoms of incontinence.[2-4] Worldwide, the prevalence is reported to be at 4%–35% in women.[5] The variability in prevalence reports is reported to be due to different study designs, different SUI definitions, patients' underreporting of relatively nonbothersome symptoms, or due to medical personnel not giving attention to symptoms of SUI, or due to an unsatisfactory medical personnel knowledge on SUI.[5,6] A study in Poland,[7] for example, showed that the knowledge in SUI of medical undergraduates was not satisfactory, which can potentially hinder the delivery of proper preventive measures and treatment as future providers of women's health care.

The authors believe that this burden can be reduced by attempts at improving methods of teaching and understanding of SUI among gynecology residents-in-training. Simulation-based teaching (SBT) has emerged as an effective training tool in response to increasing volumes of knowledge, skills, and attitudes that health workers must acquire.[8] To aid traditional teaching methods, various simulation tools are available,[9-11] for teaching SUI, including computer-based and physical simulation tools. These tools can even provide learners with a virtual environment to simulate SUI and learn about its causes, diagnosis, and treatment options. However, these tools can be costly, may not accurately represent the anatomical structures of the pelvic floor, or lead to more confusion due to complex three-dimensional (3D) spatial representations. In contrast, a low-fidelity teaching model may help to improve the understanding of SUI by serving as a memory aid and reduce cognitive overload,[12] thus facilitating anatomical problem-solving and clinical application. This study will test the success of the teaching model, as easy to construct, inexpensive, and able to efficiently teach SUI concepts.

Objectives

The primary objective of this study is to assess the efficacy of SBT with an anatomic teaching tool using objective pre- and posttest scores of the participants with learning objectives to improve an understanding anatomy, physiology, and pathophysiology concepts of SUI. The secondary objective is to elicit feedback using a self-evaluation Likert scale questionnaire for changes in the participant's self-assessment of learning, response to teaching content and resources, and overall feedback before and after the learning course.

Materials and Methods

This was a prospective observational study involving volunteer gynecology residents-in-training (year level I to IV) in a Philippine tertiary referral center. The target sample size was 54 based on the number of residents currently registered as physicians-in-training under the Department of Obstetrics and Gynecology for 2023, for a two-tailed 95% confidence and 80% level of power. Residents-in-training who gave consent were included in the study, whereas participants who have attended prior pelvic surgery video training or workshop-based training in urinary stress incontinence were excluded. These workshops were defined as training that would enable participants to do SUI procedures themselves. The residents-in-training may withdraw from the study at any time without prejudice to their rotation in the urogynecology division.

Participants were given an information sheet to document the demographic data of each resident, such as age, year level and educational exposure on SUI (no educational exposure, lectures, conferences and clinical training) followed by a ten-point MCQ pretest questionnaire based on the urogynecologic learning objectives for residents according to the American Urogynecologic Society (AUGS).[13] The pretest scores were not released to the participants.

Five batches of 10–15 participants then attended an SUI workshop in the department plenary hall. The authors created an anatomic pelvic teaching tool for SUI by designing reproducible templates available for printing [Appendix]. The residents were divided into groups of 3–4 and given a female bony pelvis, along with office materials [Figure 1]. Precut pelvic floor structures [Figure 2] made of ethynyl vinyl acetate (EVA) foam were provided. Red EVA foam represented pelvic floor muscles separated into groups according to location (deep perineal pouch, anterior triangle, anal triangle, retropubic space, pelvic sidewalls, and pelvic floor). Blue EVA foam cutouts were provided to simulate the anchoring properties of key ligaments, whereas white EVA foam cutouts represented the connective tissue support that surrounded the pelvic organs and muscles. A plastic IV tubing with a V-track controller connected to a small plastic IV solution was then tunneled through the "urethral opening" to represent the urethra and bladder. The residents were asked to construct the teaching tool using the instructions provided in a handbook for 20–30 min [Appendix].

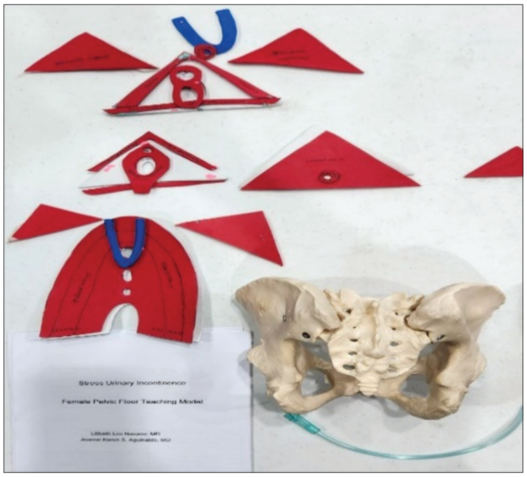

Figure 1: Ethynyl vinyl acetate foam cutouts, bony pelvis, plastic tubing, instruction manual

This was followed by a 30-minute lecture to reinforce the anatomy, physiology, and pathophysiology concepts of SUI. After the lecture, the posttest questionnaire was given wherein the passing score was set at 60% or 6 correct answers as the absolute number of points needed to pass the test. Finally, a feedback session was conducted to discuss the answers and other clarifications.

The changes noted in pre-test and post-test questionnaires, and answers on the feedback questionnaire were used as outcomes of the efficacy of the anatomic teaching model.

Descriptive analysis of the pretest, posttest, and year level were determined. Frequency and percentages were used to describe the categorical variables, whereas continuous variables were described using mean and standard deviation. Paired t-test was used to compare the pre- and posttest scores. ANOVA was used to compare the pre- and posttest scores of participants by year level. Chi-square test was used to compare the pre- and posttest answers. A $P < 0.05$ is statistically significant.

Results

There were 50 gynecologic residents-in-training that were included in the study [Table 1]. The majority of participants fall within the age range of 28–32 years. The study has a predominantly female participant group (44 out of 50 participants). The participants are relatively evenly distributed across the different year levels, with the highest number of residents in their 4th year of training. Most participants have received medical school classroom SUI instruction, whereas gynecologic conferences and clinical experience, including urogynecologic rotation, are also prominent sources of educational exposure. Fewer participants have had simulation-based training, online sources, or no SUI educational exposure.

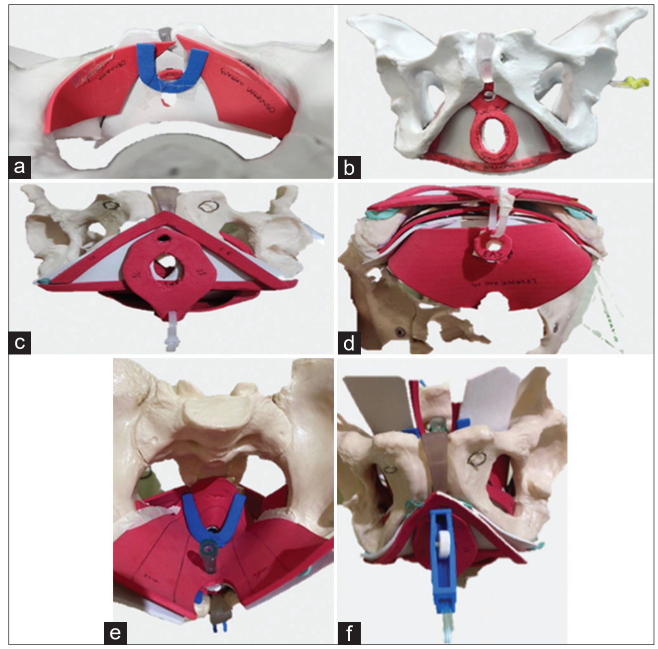

Figure 2: Ethynyl vinyl acetate (EVA) foam pelvic floor cutouts attached to bony pelvis. (a) Retropubic structures: Obturator internus muscle, Rhabdosphincter, Pubourethral ligament. (b) Structures of the deep perineal pouch: Compressor urethrae (behind ischial bones), urethrovaginal sphincter, deep transverse perineal muscle. (c) Perineal structures at the urogenital triangle: Ischiocavernosus, Bulbocavernosus. (d) Superficial transverse perineal muscle perineal structures at the anal triangle: Perineal body, External anal sphincter, Levator ani muscles (inferior view). (e) Structures of the pelvic floor: Levator ani muscle, coccygeus muscle, Arcus tendineus fascia pelvis (masking tape), uterosacral ligament, IV tubing inserted in the proximal "urethral opening". (f) Completed SUI anatomic teaching tool: EVA foam structures attached to the bony pelvis, IV tubing inserted through the distal "urethral opening," V track controller attached to IV tubing to simulate active muscle tone of structures, Small IV bottle attached to IV tubing to represent bladder (not in picture)

Table 1: Demographic data

Demographic	Category	Count
Age distribution (years)	26	1
	27	2
	28	8
	29	8
	30	12
	31	5
	32	9
	33	3
	34	2
Gender	Male	6
	Female	44
Year level	1st year	13
	2nd year	9
	3rd year	11
	4th year	17
Educational exposure	No educational exposure	4
	Classroom instruction	32
	SBT	4
	Gynecologic conferences	23
	Clinical experience	14
	Online sources	1

SBT: Simulation-based training

There were 7 out of 50 participants who passed the pretest questionnaire, whereas 38 out of 50 participants passed the posttest questionnaire at the end of the workshop [Tables 2a and b]. The mean posttest is significantly higher (6.4 versus 3.48) as compared to pretest score with a mean difference of 3.48 [Table 3].

The mean pretest and mean posttest were highest in year level 4. The mean pretest score is not significantly different between year levels with $P > 0.05$. While the mean posttest score is significantly different between the year levels with $P < 0.05$ [Table 4].

There were four residents who had SUI educational exposure through the gynecological conferences only, and they had the highest mean posttest scores. The mean pre- and posttest scores were not statistically different with respect to SUI education exposure [Table 5].

The posttest scores with correct answers were higher than pretest correct answers in anatomy questions. However, there was no significant difference between pre- and posttest correct scores of residents in the anatomy questions with $P > 0.05$ [Table 6]. The posttest scores with correct answers were higher as compared to pretest correct answers in physiology questions. However, there was no significant difference between pre- and posttest correct scores of residents in the physiology questions with $P > 0.05$ [Table 7]. The posttest scores with correct answers were higher as compared to pretest correct answers in pathophysiology questions. However, there was no significant difference between pre- and posttest correct scores of residents in the pathophysiology questions with $P > 0.05$ [Table 8].

There were only 23 (46%) who provided feedback on learning, on teaching content and resources, and overall feedback of the teaching tool. Table 9 shows that 73.9% strongly agree to recommend the course to a colleague [Table 9].

Table 2a: Pretest scores

RPT	Total participants	Passed	Failed	Passing percentage
1st year	13	1	12	7.69
2nd year	9	2	7	22.20
3rd year	11	1	10	9.09
4th year	17	3	14	17.65
Total	50	7	43	14

RPT: Resident physicians-in-training

Table 2b: Posttest scores

RPT	Total participants	Passed	Failed	Passing percentage
1st year	13	7	6	53.80
2nd year	9	7	2	77.80
3rd year	11	9	2	83.30
4th year	17	16	1	88.90
Total	50	38	12	76.90

RPT: Resident physicians-in-training

Table 3: Comparison of pre- and posttest scores

Test	Mean (SD)	Mean difference	*P*
Pretest score	3.48 (1.94)	3.48	0.001*
Posttest score	6.4 (1.52)		

**P*<0.05 is significant. SD: Standard deviation

Table 4: Compare pre- and posttest scores of each year level

Level	Pretest, mean (SD)	*P*	Posttest, mean (SD)	*P*
1 (*n*=13)	3 (1.78)	0.197	5.38 (1.19)	0.004*
2 (*n*=9)	3.89 (1.96)		6 (1.87)	
3 (*n*=11)	2.73 (2.24)		6.54 (1.13)	
4 (*n*=17)	4.12 (1.73)		7.29 (1.31)	

**P*<0.05 is significant. SD: Standard deviation

Discussion

SUI is not caused by a single factor but rather by a combination of various anatomical, physiological, and behavioral factors. The etiology of SUI is popularly explained by three existing theories which focus on the pathologic support of the suburethra and the anterior vaginal wall. These prevailing and accepted theories are (1) urethral hypermobility/Hammock theory, (2) intrinsic sphincter deficiency theory, and (3) integral theory.[14] However, teaching these SUI concepts and theories can be difficult because the structures responsible for urinary continence, such as the pelvic floor muscles, paravaginal support, periurethral structures, structures within the deep perineal pouch, and the retropubic space, are not easily appreciated during routine gynecological examinations or operations. This lack of visibility might make it challenging for them to develop a deep understanding of the complex anatomy, physiology, and pathophysiology of SUI. Conventionally, teaching methods to explain SUI include classroom instruction with illustrations to explain the functional anatomy of the female pelvic floor and stress continence mechanism. However, these resources usually have oversimplified structures or do not accurately reflect their relationships, leading to misunderstandings among learners.

In addition, not all gynecologic teaching institutions have cadaver access to real-life-anatomical specimens. The absence of cadaveric learning opportunities can hinder residents' ability to develop a tactile understanding of pelvic floor anatomy.

To address these challenges, educators have explored alternative methods and technologies to enhance the teaching of pelvic floor anatomy and SUI. Online resources,[10,11] such as interactive anatomical atlases and virtual dissection tools, can supplement traditional teaching materials. Such high-fidelity digital models

Table 5: Comparison of pre- and posttest score with respect to stress urinary incontinence educational exposure

SUI education	Pretest	P	Posttest	P
No SUI education exposure				
Mean	2.50	0.364	5.50	0.778
n	4		4	
SD	1.915		3.109	
Medical classroom SUI education and clinical experience (including urogynecologic rotation)				
Mean	3.40		5.40	
n	5		5	
SD	2.074		2.510	
Medical classroom SUI education and gynecological conferences				
Mean	3.50		5.50	
n	14		14	
SD	1.829		1.092	
Medical classroom SUI education and simulation-based learning (another anatomic SUI tool)				
Mean	2.50		5.75	
n	4		4	
SD	2.380		2.986	
Medical classroom SUI education only				
Mean	3.33		6.11	
n	9		9	
SD	1.658		2.088	
Medical classroom SUI education, gynecologic conferences, and clinical experience (including urogynecologic rotation)				
Mean	3.00		7.00	
n	1		1	
SD				
Clinical experience (including urogynecologic rotation and online SUI sources				
Mean	5.00		7.00	
n	1		1	
SD				
Clinical experience (including urogynecologic rotation) only				
Mean	4.00		6.33	
n	3		3	
SD	1.000		1.528	
Gynecologic conferences only				
Mean	3.75		7.25	
n	4		4	
SD	3.304		0.957	
Gynecological conferences and clinical experience (including urogynecologic rotation)				
Mean	4.60		5.40	
n	5		5	
SD	2.302		1.817	

SUI: Stress urinary incontinence, SD: Standard deviation

of human anatomy include those based on actual cross-sectional images of the human body with increasing hyperrealism and ease of access to learners. In addition, 3D printing technology[11] allows educators to create physical models of pelvic floor structures from digital anatomical data. These models can be used for hands-on learning and exploration, offering a realistic representation of the pelvic floor; however, this takes hours of rendering, printing, and are generally expensive.

In contrast, low-fidelity anatomic and physiologic models do not exactly resemble the body part they are representing and usually have just key structures. For example, Lirazan and Aguinaldo[15] tested a sock model to teach gynecologic residents the concept of POPQ staging with statistically significant improvement in posttest scores. Although the sock model lacked realistic surface details, it showed strong correspondence to the relationship of the represented uterovaginal structures in patients with prolapse. Similarly, Smith and Husmann[16] demonstrated a low-cost, active learning module tested on medical students with a three-dimensional understanding of perineal anatomy using masking tapes and pipe cleaners to simulate the pelvic structures on

Table 6: Improvement in posttest with anatomy questions

Anatomy	Pretest correct answers from participants, *n* (%)	Posttest correct answers from participants, *n* (%)	*P*
The resident should demonstrate an understanding of the normal anatomy, including the bladder, urethra, and pelvic floor based on the anatomic teaching model and lecture provided (bladder)	18 (36)	27 (54)	0.4664
The resident should demonstrate an understanding of the normal anatomy, including the bladder, urethra, and pelvic floor based on the anatomic teaching model and lecture provided (urethra)	12 (24)	39 (78)	
The resident should demonstrate an understanding of the normal anatomy, including the bladder, urethra, and pelvic floor based on the anatomic teaching model and lecture provided (urethra)	22 (44)	34 (68)	
The resident should demonstrate an understanding of the normal anatomy, including the bladder, urethra and pelvic floor based on anatomic teaching model and lecture provided (vagina)	17 (34)	29 (58)	
The resident should demonstrate an understanding of the normal anatomy, including the bladder, urethra, and pelvic floor, based on the anatomic teaching model and lecture provided (perineum)	21 (42)	45 (90)	
The resident should demonstrate an understanding of the normal anatomy, including the bladder, urethra, and pelvic floor based on the anatomic teaching model and lecture provided (levator ani muscles)	8 (16)	20 (40)	

Table 7: Improvement in posttest with physiology questions

Physiology	Pretest correct answers from participants, *n* (%)	Posttest correct answers from participants, *n* (%)	*P*
The resident should demonstrate a working understanding of the normal function of the lower urinary tract during the filling and voiding phases	33 (66)	42 (84)	0.8214
The resident should demonstrate the urodynamic volume/pressure relationships of the urethra and bladder during filling and emptying	18 (36)	25 (50)	

Table 8: Improvement in posttest with pathophysiology questions

Pathophysiology	Pretest correct answers from participants, *n* (%)	Posttest correct answers from participants, *n* (%)	*P*
Understand the underlying anatomic abnormality that allows urinary loss in this condition (intrinsic sphincter deficiency)	11 (22)	14 (28)	0.8904
Understand the underlying anatomic abnormality that allows urinary loss in this condition (urethral hypermobility/loss of suburethral support)	25 (50)	34 (68)	

Table 9: Effectiveness of teaching tool in the understanding of stress urinary incontinence

	Strongly agree	Agree	Neither agree or disagree	Disagree	Strongly disagree	Total
Feedback on learning						
I have improved my knowledge of SUI from this workshop	13	10	0	0	0	23
My expectations of learning SUI were adequately fulfilled after this workshop	10	13	0	0	0	23
Feedback on teaching content and resources						
The resources used in this simulation-based teaching have supported my learning on SUI	12	11	0	0	0	23
The objectives of this workshop were adequately reached with respect to time allocated	15	8	0	0	0	23
Overall feedback						
Would you recommend this course to a colleague?	17	6	0	0	0	23

SUI: Stress urinary incontinence

the bony pelvis. Ramkumar and Sharma[17] developed a home-based model based on the integral theory and compared SBT with video-based learning, which showed better posttest performance of medical students in the SBT group. Sponge, straws, rubber bulb mucus sucker, and linen and cotton cloth were used to simulate pelvic organs, membranes, and ligaments. While these models intend to facilitate learning, it is important to provide students with sufficient explanations to establish the connection between the models and the corresponding body parts during anatomy teaching.

Therefore, in the context of teaching SUI to gynecologic residents-in-training, the authors designed an anatomic teaching tool which focused on the pelvic floor to emphasize their anatomic and structural relationships in their role for urinary continence. White EVA foam was used to simulate the properties of healthy connective tissues[18] (glycosaminoglycans: Substance, elastin: Energy, collagen: Rigidity). Red EVA foam muscle cutouts were provided and separated into groups according to location to aid memory by compartmentalization. Blue EVA foam ligament cutouts were provided to simulate the anchoring properties of key ligaments in the urinary continence mechanism. A plastic IV tubing with a V-track controller connected to a small plastic IV solution was then tunneled through the "urethral opening" to represent the urethra and bladder. The anatomic teaching tool was supplemented by a lecture on anatomy, physiology, and pathophysiology, frequently comparing textbook illustrations and concepts to the model. Because the teaching tool comprised structures with topographically mapped origins and insertions in the bony pelvis, simple dynamic movements (pubococcygeus active forward contraction, levator plate backward directional movement, and fixed pubourethral ligament support at the midurethra) were appreciated to demonstrate the mechanical interplay between the pelvic organs, connective tissues, and muscles in providing urinary continence.

The posttest passing percentages and posttest scores were notably higher across all year levels than pretest scores, indicating a positive impact of the teaching approach in enhancing residents' comprehension.

Interestingly, year level 4 residents exhibited the highest mean pre- and posttest scores, possibly suggesting a cumulative effect of their previous training and exposure, including a month-long urogynecologic rotation. In line with this, the authors wanted to evaluate the influence of educational exposure on participants' performance, revealing that residents with educational exposure through gynecologic conferences had the highest mean posttest scores. However, the mean pre- and posttest scores were not statistically different across different types of educational exposure. This suggests that the SBT approach was effective regardless of the participants' prior educational background.

Since this was an anatomic teaching tool, the authors were expecting an increase in correct anatomy answers in the posttest scores. All posttest scores demonstrated improvements in anatomy, physiology, and pathophysiology questions. Despite the increase in correct answers in the posttest, the P values indicated that the improvements were not statistically significant. This might be attributed to the relatively small sample size or the number of questions and the type of questions asked. Finally, the feedback collected from participants regarding the learning experience and the teaching tool's effectiveness was overall positive. Some participants commented on maintaining three residents: 1 teaching tool ratio and suggested longer minutes on both the teaching tool construction and lecture portions of the workshop. Overall, a significant proportion of participants strongly agreed to recommend the course to colleagues, indicating a high level of satisfaction with the intervention.

Limitations

The study included a relatively small sample size of 50 gynecologic residents-in-training from a single institution, which might affect the generalizability of the findings to a broader population of gynecologic trainees. In addition, participants who volunteered for the study might have had a higher motivation to learn, leading to a potential selection bias. The study also only assessed immediate posttest scores to measure short-term learning retention. The study's reliance on a single facilitator to provide consistency in delivery may introduce facilitator bias and limit diverse teaching perspectives. The authors acknowledge the lack of comparing the SBT with traditional teaching methods which could provide more insights into the relative effectiveness of the simulation-based approach.

Conclusion

Teaching SUI concepts and theories poses challenges due to the intricate nature of the anatomical structures involved. This study introduced an anatomic teaching tool that aimed to enhance gynecology residents' understanding of SUI. The tool combined physical models of pelvic floor structures, representative materials, and dynamic movements to illustrate the mechanical interplay crucial for urinary continence. These hands-on elements were supplemented by lectures that compared textbook concepts to the model, to complement the learning experience. The residents at different year levels exhibited enhanced posttest passing percentages and scores, indicating the approach's efficiency across various stages of training.

Considering the ease of production, improved test scores, and participants' enthusiasm, the incorporation of the anatomic teaching tool for its use in SUI education should be encouraged. Future studies with larger and more diverse samples are warranted to validate these findings, especially the long-term retention of the knowledge acquired.

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Authorship contributions

Lilibeth M. Lim Navarro, MD - Concepts, Investigation, and Manuscript writing.

Joanne Karen S. Aguinaldo, MD - Concepts, Design, Definition of intellectual content, Manuscript writing.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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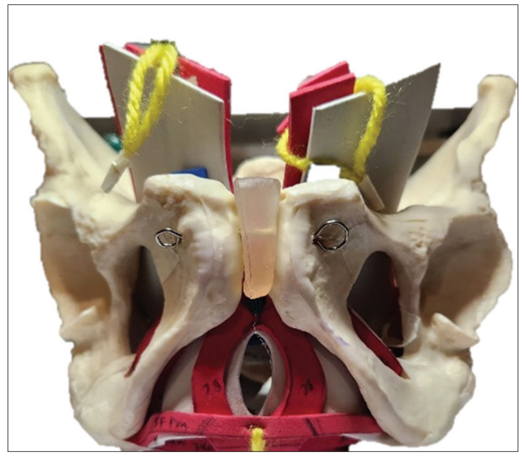
Appendix

(may be requested from the First Author)

Materials needed:



Pre-cut pelvic floor structures (EVA foam).

Masking Tape.

Strings or Zip Ties.

Scissors, Cutter.

Bony Pelvis/Plastic Pelvis Model.

Pens/Markers.

Flexible Plastic Tubing (optional).

Image created by authors.

Structures Discussed:

Perineal Membrane	Longitudinal muscle of the anus
Sphincter urethrae	Arcus tendineus fascia pelvis
Compressor urethrae	Pubourethral ligament
Urethrovaginal sphincter	Uterosacral ligament
Deep transverse perineal muscle	Levator plate
Ischiocavernosus muscle	Iliococcygeus muscle
Bulbospongiosus muscle	Pubococcygeus muscle
Superficial transverse perineal muscle	Puborectalis muscle
Urogenital triangle	Coccygeus muscle
Anal triangle	Obturator internus muscle
External anal sphincter	Pubocervical and rectovaginal fascia
Perineal body	Urethra, vagina*, rectum*

*Optional

1. Begin by tracing templates on EVA foam [Appendix]. These will serve as the (a) Pelvic diaphragm, (b) Urogenital triangle, (c) Anal triangle, (d) muscles, and (e) ligaments and fascia
2. Cut tracings and follow template instructions for labeling. Cut holes and slits and assign the urethra, vagina, and anus accordingly.

Attachments, origins, and insertion of structures can be seen Appendix for reference.

1. Fill in the structures of the deep perineal pouch: place the sphincter urethrae and the pubourethral ligament behind the perineal membrane, then place the compressor urethrae, the urethrovaginal sphincter, and the deep transverse perineal muscle anteriorly. Secure structures using masking tape or adhesive tacks [Figure 1]
2. Fill in the structures at the urogenital triangle [Figure 2] ischiocavernosus and bulbospongiosus and superficial transverse muscles. Secure using masking tape or adhesive tacks. Insert strings or zip ties at the inferior arms of the bulbospongiosus muscles and medial aspect of the superficial transverse perineal muscle. The ends of the strings/zip ties should meet at the midline to simulate their tendinous insertion into the "perineal body"
3. On the anal triangle, cut a hole in the center to represent an opening for the anal canal. Use masking tape or adhesive tacks to secure the posterior aspect of the levator ani muscle and the external anal sphincter. Insert strings into the superior aspect of the external anal sphincter to represent its insertion into the "perineal body" [Figure 3

for the completed structure]

4. Cut the pelvic diaphragm/floor and the levator ani muscle. Insert strings/zip tie into the slit at the sacral side of the levator ani muscles to represent the tendinous insertions into the levator plate. Insert string or zip tie into the slits on the pubic arms of the pubococcygeus muscle to represent forward movement. Secure structures using masking tape or adhesive tacks. Place the uterosacral ligament from its origin at S2, S3 and its approximate insertion into the posterior cervix at the vaginal opening [Figure 4]
5. Hold the pelvic bone and place the obturator internus muscles in the retropubic space from its origin at the pubic and ischial bones at the obturator membrane, spanning the pelvic sidewall up to its insertion at the (lesser) sciatic foramen [Figure 5a]
6. By sticking a small ball of adhesive tack on each corner of the perineal membrane triangle, place the base of the triangle on the posterior aspect of the inferior pubic ramus and the apex of the triangle on the posterior aspect of the pubic symphysis [Figure 5b]
7. Similarly, place the urogenital triangle on the pelvis by attaching its base to the ischial tuberosities and its apex near the anterior aspect of the pubic symphysis [Figure 6]. Align the urethral and vaginal openings
8. Place the anal triangle in its anatomical position by attaching the apex to the tip of the coccyx, and the base to the ischial tuberosities [Figure 7a]
9. Collect ends of all strings/zip ties from the urogenital and anal triangle at the midline to represent the tendinous “perineal body” using masking tape
10. Attach the coccygeus muscle from its insertion from the ischial spine to its origin from the inferolateral aspect of the coccyx [Figure 8a]
11. The pelvic diaphragm/floor with the levator ani muscle can now be added by sliding it through the pelvic inlet until it rests in a cone shape within the pelvis, with aligned openings for the urethra, vagina and anus, and attach uterosacral ligament at its approximate insertion at the “cervix” posteriorly and its point of origin at S2, S3 [Figure 8b]
12. Place masking tape with the label “arcus tendinous fascia pelvis” [Figure 8c] from the lateral pubic aspect of the iliococcygeus muscle to its insertion into the ischial spines on each side. Insert a zip tie/string into the posterior slit made on the levator ani muscles to represent the tendinous anococcygeal raphe and secure it with posteriorly toward the sacrum
13. Tunnel a plastic tubing into the urethral opening [Figure 9]. Observe as it tunnels into the sphincter urethra, perineal membrane, compressor urethra surrounded by the urethrovaginal sphincter, and through the urethral opening at the urogenital triangle. Attach clamp roller to “urethra” to represent the active tone of above muscles at the mid-urethra.

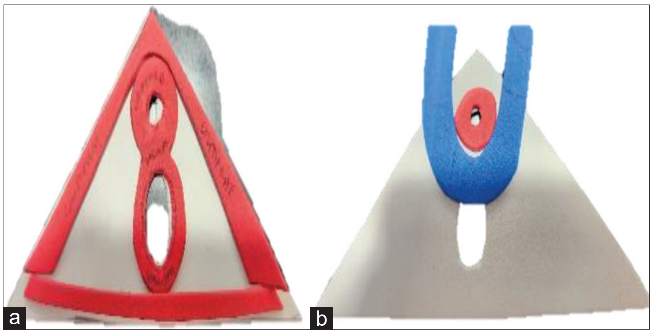


Figure 1: Structures of the deep perineal pouch. (a) Anterior, (b) Posterior

Figure 3: Anal triangle

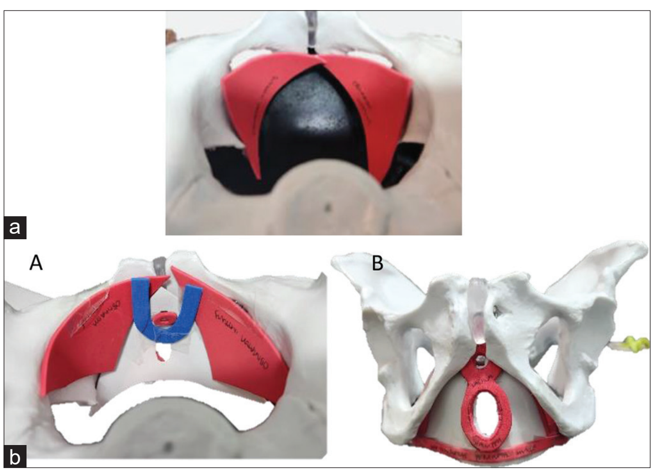


Figure 5: (a) Obturator internus muscle. (b). Structures of the deep perineal pouch seen from the (A) retropubic space and (B) anterior view

Figure 2: Structures of the urogenital triangle

Figure 4: Pelvic diaphragm with uterosacral ligament

Figure 6: Urogenital triangle

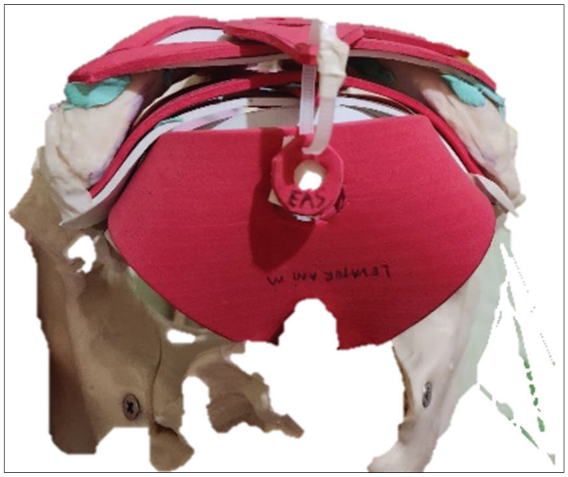


Figure 7: Perineal body formed with zip ties

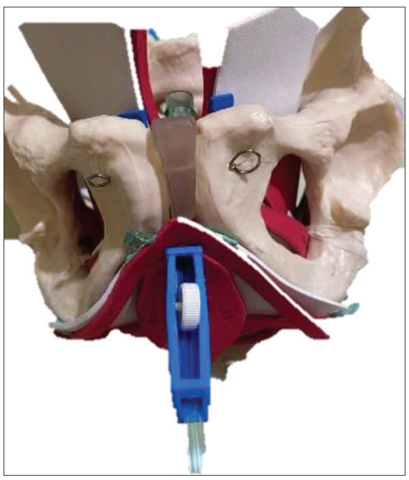


Figure 9: Tunneling a plastic tubing into the urethral opening

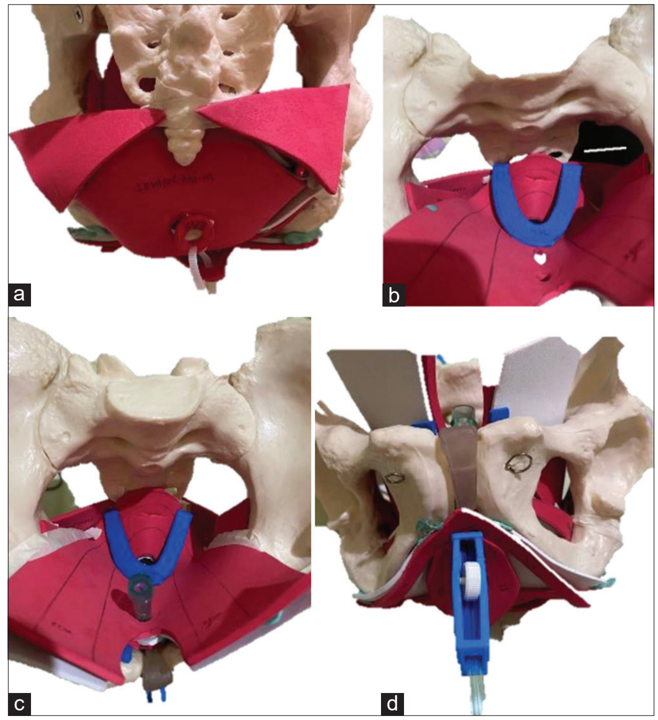


Figure 8: (a) Coccygeus muscle (b) Levator ani muscles (LAM) and coccygeus muscle with Uterosacral ligament (uterus not in picture) (c) White masking tapes represent the arcus tendineus fascia lata or “white line” connecting LAM to pelvic side wall (d) completed anatomic SUI teaching tool

Reproducible Templates