UROGYNECOLOGY PATIENT EDUCATION:
VISUALIZING SURGICAL MANAGEMENT OF PELVIC ORGAN PROLAPSE

by
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A thesis submitted to Johns Hopkins University in conformity with the requirements for the degree of Master of Arts

Baltimore, Maryland
March, 2014

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ABSTRACT

Pelvic organ prolapse (POP) is a common condition among postmenopausal women, with some 200,000 corrective surgeries being performed annually in the United States. Prolapse occurs due to weakened support of the pelvic organs, allowing them to herniate into, or beyond, the vaginal opening.

The female pelvis is a complex anatomical region, with increasing complexity during POP. Despite detailed, preoperative counseling, most women have difficulty understanding the options, benefits, and risks of their upcoming surgical procedure. There are limited visual resources available to assist patients in their education of POP. Accessible patient-oriented illustrations favor static before-and-after views, leaving patients to guess the intermediate stages of prolapse. Existing surgical illustrations are often graphic and overly complex for patients. Current animations may enhance understanding, however, they utilize dark, intense color palettes, robotic narrations, and bulky three-dimensional models, creating an uninviting, foreboding atmosphere.

Three patient-friendly animations were created to assist patients in the understanding of their condition. The first animation provides an overview of POP prevalence, symptoms, and anatomy. The second and third animations explain two different corrective surgical procedures available to women, a sacral colpopexy and a uterosacral suspension.

POP is a sensitive topic because it involves a woman’s reproductive organs. Therefore, simplified anatomy, inviting colors, on-screen text, and a female narration were incorporated to appeal to patients. Effectiveness of the animations was assessed through direct participation with patients and the use of questionnaires. First, patients completed a pre-counseling questionnaire, then viewed all three animations, and finally completed a post-counseling questionnaire.

Particular attention was given to patient reaction and feedback. Patients found that the animations provided a successful visual aid to assist in their understanding of pelvic organ prolapse and the surgical options available to them. Anatomical landmarks, such as attachment sites of the vagina and surgical mesh, remained unclear to some patients after a single viewing of
the animations. The animations are available online to allow patients to review them and share them with family.

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ACKNOWLEDGEMENTS

This project would not have been made possible without the support and guidance of a wonderful group of individuals.

Thank you to Gary Lees Chairman, Associate Professor of the Department of Art as Applied to Medicine, Johns Hopkins University of Medicine, for serving as my departmental advisor. I am so grateful for your guidance, patience, and enthusiasm during the production of my thesis and throughout my time as a student.

I would like to thank Dr. Victoria Handa Professor of the Department of Gynecology and Obstetrics, for serving as my preceptor and for her expertise, encouragement, and commitment throughout every step of this project.

Much thanks to Dr. Jennifer Hallock for her knowledge and inspiration during the conception, creation, and assessment of this project. Thank you to Dr. Tola Fashokun and Dr. Grace Chen for your valuable feedback and support.

Thank you to the Vesalius Trust for the generous financial support for this project.

And last, but certainly not least, thank you to all of my classmates, the faculty, and staff in the Department of Art as Applied to Medicine. I could not have done this without you.
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INTRODUCTION

OVERVIEW

Pelvic organ prolapse (POP) is a common condition in postmenopausal women. About 200,000 corrective surgeries for POP are performed annually in the United States (Jelovsek 2014). The prevalence of POP is projected to increase significantly within the next 40 years, with 43.8 million American women predicted to experience at least one pelvic floor disorder in 2050 (Wu et al. 2009).

Life expectancy for women is increasing, as well as an increased expectation for quality of life after menopause. POP often affects a women’s ability to be social and active due to daily discomfort and interference with an active lifestyle and sexual function. Symptoms include pelvic pressure, sensations of vaginal bulging, urinary or fecal incontinence, or protrusion of vaginal tissue, which may lead to chronic discharge or ulceration. Women who experience symptomatic POP are candidates for surgical repair of their prolapse (Jelovsek 2014).

The female pelvis contains important organs such as the uterus, vagina, bladder, and rectum. Weakening of the support of these organs may lead to their prolapse into, or beyond, the opening of the vagina. Loss of support can be caused by damage to any of the supportive systems of the pelvis, including the bony structure, pelvic diaphragm, endopelvic fascia, and the perineal membrane (Walters and Ridgeway 2013).

PROBLEM

The female pelvis is a complex anatomical region and POP is a uniquely difficult condition to understand. Many patients, even those with high health literacy scores (Anger 2012), have a difficult time visualizing normal versus abnormal pelvic anatomy. A problem frequently encountered in clinical practice is how to effectively explain surgical options to women with POP. Patients must be able to make informed decisions and clearly understand the benefits and risks of each option. A lack of understanding of the surgical options available may lead to an inability to give informed consent.
Despite detailed, preoperative counseling sessions, many women continue to have deficiencies in the understanding of their imminent surgical procedure. It is difficult for surgeons to communicate balanced, complex, and personalized information to patients during a traditional counseling session. In addition, surgeon preference may influence the way in which surgical options are presented to patients (Berman 1996).

There are currently limited patient-oriented visuals available for use in the clinic during preoperative discussions. Surgeons often resort to the use of images from surgical textbooks, which can be overly complex, graphic, and confusing to patients. Existing patient education illustrations often depict static, before and after anatomy of POP, which becomes confusing to patients as they are unable to visualize the course of an organ as it prolapses. Existing patient education animations favor a dark, intense color palette, as well as bulky, three-dimensional models, and robotic narratives, creating an ominous, uninviting atmosphere (Pelvic Prolapse 2014; Vaginal Prolapse 2014). New methods to improve patient education and comprehension should be considered.

OBJECTIVES

Three concise, friendly, and accurate animations will be created as a visual guide for the patient education of POP. Inviting color pallets, motion graphics, and patient-oriented illustrations will teach women about POP and demonstrate different surgical options available to patients. Animation 1 will include normal pelvic anatomy, prolapsing anatomy, and POP symptoms. Animation 2 will explain a sacral colpopexy procedure and animation 3 will explain a uterosacral suspension procedure. Completed animations will be shown to current POP patients to assess whether or not viewing the animations assisted in their understanding of POP and its surgical management.
MATERIALS & METHODS

BACKGROUND RESEARCH

A comprehensive list of research articles was compiled using the Welch Medical Library e-resources (see bibliography). Chapter 36A, Pelvic Organ Prolapse: Basic Principles, and 36E, Vaginal Vault Prolapse, of *Te Linde’s Operative Gynecology* was also read. A “Google” search was performed to locate existing POP educational illustrations and animations readily accessible to patients.

SURGICAL OBSERVATION

Before viewing any surgical procedures, surgical processes were researched using both *Te Linde’s Operative Gynecology* and procedural notes provided by the attending surgeons. A total of seven surgical procedures were observed. Three surgeries were observed in the operating room at the Johns Hopkins Bayview Medical Center, one open sacral colpopexy, one laparoscopic sacral colpopexy, and one uterosacral suspension. Four additional procedures were observed through videos.

During observation in the operating room, rough sketches were made and photographs were taken. Sketches were refined and reviewed for accuracy, by the surgeon who performed the procedure, for use as references during illustration creation. (Fig. 1).
Figure 1a. Sketch of a mid-sagittal section of normal, female, pelvic anatomy

Figure 1b. Sketch of a mid-sagittal section of a prolapsed uterus
Figure 1c. Sketch of a mid-sagittal section of a prolapsed vagina

Figure 1d. Sketch of a mid-sagittal section of a suspended vagina after a sacral colpoperx procedure
NARRATION AND STORYBOARD

After reading and reviewing compiled references, key words were identified and a corresponding plot line was determined. Three storyboards, one for each animation, were created in pencil. The narration was included below each thumbnail to ensure an alignment of artwork and voiceover during animating (Fig. 2).
Storyboards and the accompanying narrations were reviewed and finalized (Appendix A). The final narration was recorded and edited using Adobe® Audition (Appendix B). Storyboards were beneficial during editing of the narration to ensure appropriate pauses were inserted during anticipated image labeling and transitions.

ILLUSTRATIONS

Female pelvic anatomy was illustrated and edited for import into animating software. A female bony pelvis specimen was positioned and directly observed to record accurate sketches of the bony structure. Soft tissue visual references were gained through direct observation and photography in the operating room, during autopsy, and during cadaveric dissection. MRI and CT scans of pelvic specimens, both with and without pelvic organ prolapse, medical sculptures, and existing illustrations were also referenced.

Preliminary sketches of the illustrations were created in pencil and reviewed for accuracy (Fig. 3). Board art was then produced using traditional watercolor painting. Production of the board art was carefully planned for future use within Adobe® Photoshop CC and Adobe® After Effects CC (Fig. 4). During production, several of the pieces were painted individually to eventually achieve the transparencies required for certain animation effects and transitions. Completed board art was scanned at 600 dpi with a large format color scanner (Microtek® ScanMaker) and imported into Photoshop.

![Figure 3. Preliminary sketches created for the uterosacral suspension animation. The image on the left depicts a mid-sagittal cut in the pelvic organs.](image-url)
Figure 4. Example of board art for a three-quarter view of the pelvis. These elements were painted separately and later combined within Photoshop.

The scanned images were edited within Photoshop using adjustment layers for hue/saturation, levels, and brightness. Highlights, shadows, vignettes, and other similar modifications were made using masking and digital painting techniques. Adobe® Illustrator CC was used to create smooth, vector-based contour lines for import into Photoshop (Fig. 5). Final images were exported from Photoshop in a .PNG format. The final animation used a high-definition television standard 16:9 image ratio, with a pixel dimension of 1920 by 1080. Images were exported at no less than 100% of their final image size.

Figure 5. Progression of digital editing of illustrations, from scanning stage to animation-ready stage. (a) Illustration after scanning, (b) illustration after editing, (c) illustration after importing contour lines
Line work throughout the illustrations and graphic elements, such as the figure icons and silhouettes, was created within Illustrator (Fig. 6). The “Pen” tool was used to create strokes and the “width” tool was used to adjust and vary the weight of the stroke throughout the image to achieve a more organic look.

Figure 6. Examples of illustrations containing line work. These images appear in animation 1 during descriptions of common POP symptoms.

ANIMATIONS

Animations were created using After Effects. Key words and phrases are emphasized throughout the animation by appearing as text upon the screen as they are spoken through the narration. Text was added within After Effects using the “Text” tool. The text appears to “swing” down onto the screen. This was achieved by selecting the “3D Layer” box, which allows layers to be manipulated along the “X”, “Y”, and/or “Z” axis, and selecting the “Motion Blur” box, to simulate shutter duration (Fig. 7).

Figure 7. “Swinging” text effect achieved by selecting the Motion Blur and 3D Layer box. This allows fine control of rotation along all three axes.
The motion of the prolapsing uterus and prolapsing vagina was achieved by fading a series of still images sequentially in and out of view. For example, ten still images of the varying stages of uterine prolapse were illustrated and imported into After Effects (Fig. 8).

Figure 8. Ten still images of the prolapsing uterus were created to animate uterine prolapse within After Effects.
The images were layered in sequential order and then chronologically faded on and off the screen, giving the appearance of movement of the uterus (Fig. 9).

Figure 9. Still illustrations were layered to fade sequentially on and off the screen to create the prolapsing movement of the uterus.

The motion of the surgical mesh as it floats down the screen, in animation 2, was achieved using the “Bezier Warp” effect. This allowed fine control of each vertex and tangent of an imported image of the mesh (Fig. 10). A key frame was made for each modification of these points as the mesh moved down the screen along the “Y” axis. This produced the appearance of a lightweight, drifting material.
Figure 10. The Bezier Warp effect was used to create the drifting movement of the mesh as it moved down the screen.

ASSESSMENT

Approved IRB study NA_00088382, Education patients about surgical options for pelvic floor disorders, was used to test the effectiveness of the three animations during use in a pre-surgical counseling session. Attending physicians obtained informed consent from a population of patients who were considering surgery for POP. Patients completed a pre-counseling questionnaire, viewed all three animations during a pre-surgical counseling session with their physician, and completed a post-counseling questionnaire (Appendix C). A total of 11 patients participated in this assessment.
RESULTS

FINAL ANIMATIONS

Three animations were created using After Effects. Animation 1 establishes the prevalence of POP, the most common symptoms, and both normal and POP female pelvic anatomy (Fig. 11-17). Animation 2 explains a sacral colpopexy, which is a reconstructive surgical option for patients with symptomatic POP (Fig. 18-23). Animation 3 explains a uterosacral suspension, an alternative reconstructive surgical procedure for symptomatic POP patients (Fig. 24-26).

Figure 11. Animation 1 screenshot: Opening screen

Figure 12. Animation 1 screenshot: Statistic establishes the prevalence of POP
Figure 13. Animation 1 screenshot: The most common symptoms of POP

Figure 14. Animation 1 screenshot: Three-quarter view identifying normal anatomy

Figure 15. Animation 1 screenshot: Mid-sagittal section identifying normal anatomy

Figure 16. Animation 1 screenshot: Mid-sagittal section of uterine prolapse, with an inset of the view from outside the body
Figure 17. Animation 1 screenshot: Mid-sagittal section of vaginal prolapse, with an inset of the view from outside the body

Figure 18. Animation 2 screenshot: Abdominal incision scar location

Figure 19. Animation 2 screenshot: Minimally invasive scar location

Figure 20. Animation 2 screenshot: Uterus fading away to indicate a hysterectomy
Figure 21. Animation 2 screenshot: Surgical mesh after drifting down the screen

Figure 22. Animation 2 screenshot: Three-quarter view, with a mid-sagittal cut in the pelvic organs, showing repositioning of the vagina

Figure 23. Animation 2 screenshot: Three-quarter view showing location of mesh attachments

Figure 24. Animation 3 screenshot: Indicating surgical approach through vaginal opening
RESULTS

Figure 25. Animation 3 screenshot: Indicating that no scars will be visible after surgery

Figure 26. Animation 3 screenshot: Identifying the uterosacral ligaments and sutures applied during surgery

ASSESSMENT

A total of 11 patients were administered a pre-counseling patient questionnaire and a post-counseling patient questionnaire (Appendix C). The post-counseling questionnaire required patients to assess the effectiveness of the final animations using a Likert scale. Patients rated the animations on a scale from 1 to 5, with 1 being “completely disagree” and 5 being “completely agree”. Patients indicated an average of a 4.8 when prompted with the statement, “This visual aid helped me understand my condition”. Patients also indicated an average of a 4.6 when prompted with the statement, “This visual aid helped me understand the surgery”.

ASSET REFERRAL

Access to the website and animations resulting from this thesis can be viewed at the Johns Hopkins Bayview Medical Center website, http://www.hopkinsmedicine.org/johns_hopkins_bayview/medical_services/primary_care/obstetrics_gynecology/clinical_services/
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gynecology/center_for_pelvic_health/understanding_pelvic_disorders.html, or by contacting Samantha Welker at swelkerillustration@gmail.com. The author may also be reached through the Department of Art as Applied to Medicine via the website www.hopkinsmedicine.org/medart.
DISCUSSION

The subject matter for this project may be considered sensitive to some patients because it involves the reproductive organs. In addition, pelvic anatomy is highly complex and difficult for patients to understand. Women who do not understand their condition may experience fear and apprehension and avoid seeking treatment (Anger 2012). Therefore, the information included in each animation was carefully considered. The artwork created for this project was highly simplified and illustrative and pelvic anatomy irrelevant to patient understanding of POP was excluded. In addition, a soft, feminine color palette was used to generate an inviting atmosphere.

Overall, patients agreed that the animations provided a successful visual aid to assist in their understanding of pelvic organ prolapse and two of the surgical options available to them. During open-ended questions, patients mentioned that they appreciated the simplified anatomy and the pleasing color palate. In addition, they welcomed the short length of the animations, stating that longer animations may have exceeded their attention span. After viewing the animations, patients expressed a increased level of comfort regarding their condition and potential surgical procedure.

Patients found it most difficult to recall whether or not one option for surgery included attachment of the vagina to the uterosacral ligament or the sacrospinous ligament. The anatomical terminology remained unclear after only a single viewing of the animations. However patients mentioned that these terms did look familiar. During animation 2, which explains a uterosacral suspension, the vagina is attached to the uterosacral ligament. However, another common option for POP reconstructive surgery is a sacrospinous fixation. During this procedure, the woman’s vagina is attached to one of her sacrospinous ligaments. This particular surgical procedure was not included in any of the animations. A fourth animation of a sacrospinous fixation could be created to help eliminate confusion among patients.

To assist with recall and understanding, patients are able to revisit the animations and replay any portions that were unclear. The animations have been made accessible through the Johns Hopkins Medicine Website.
Future endeavors related to this project include plans to continue administering patient questionnaires until the total number of patient participants will allow for a statistically significant calculation of the effectiveness of the animations and their use in patient education.
Project: ANIMATION 1: INTRODUCTION

Audio: These organs are held in place by a bony structure called the pelvic floor.

Audio: Weakening of the support from the pelvic floor can allow these organs to slip out of place and protrude into or beyond the opening of the vagina.

Audio: Surgery can be performed to correct prolapse. The type of surgery depends on which organs are involved.

Audio: If the uterus, or vagina, is prolapsed, it is called vaginal vault prolapse.

Audio: If a hysterectomy has not been performed and the uterus is still present, the uterus may prolapse through the vagina.

Audio: If a hysterectomy has been performed, and the ovaries are left in place, the top of the vagina may prolapse outside of the body.
Project: POP Animation #2: SACRAL COLPOPEXY

Audio: If the uterus has prolapsed, outside of the body.
Audio: or the vagina has prolapsed, outside of the body.
Audio: a doctor may recommend a surgery called a sacral colpophxy.
Audio: A sacral colpophxy can be performed through an abdominal incision, which leaves a small scar just below the bikini line.
Audio: or it may be performed through a minimally invasive, laparoscopic technique, leaving a very small scar in the abdomen.
APPENDIX B: NARRATION

Animation 1: Pelvic Organ Prolapse

Pelvic organ prolapse is a common condition. About one in every ten women will undergo surgery for the prolapse of their uterus or vagina.

Pelvic organ prolapse symptoms include sensations of pressure in the pelvis, the sensation of the vagina bulging outwards and/or downwards, and having difficulty urinating and defecating.

The female pelvis is a complex, three-dimensional structure. It contains the bladder, vagina, uterus, and rectum. These organs are held in place by a muscular structure called the pelvic floor. Weakening of the support from the pelvic floor can allow these organs to slip out of place and prolapse into or beyond the opening of the vagina.

Prolapse can involve one or more of these organs. If the uterus or vagina is prolapsing it is called a uterovaginal prolapse. If a hysterectomy has not been performed, and the uterus is still present, the uterus may prolapse through the vagina. If a hysterectomy has been performed, and the uterus is no longer present, the top of the vagina may prolapse outside of the body.

Animation 2: Sacral Colpopexy

Sacral colpopexy. If the uterus has prolapsed outside of the body, or the vagina has prolapsed outside of the body, a doctor may recommend a surgery called a sacral colpopexy.

A sacral colpopexy can be performed through an abdominal incision, which leaves a small scar just below the bikini line. Or it may be performed through a minimally invasive, laparoscopic technique, leaving three to five very small scars on the abdomen. If the uterus is still present, a hysterectomy may also be performed during this surgery.

During a sacral colpopexy, a strap is created out of a surgical mesh material. This strap is used to reposition and suspend the vagina back into its original position. The mesh is attached to the front and back of the vagina and then to the sacrum, or tailbone.
Animation 3: Uterosacral Suspension

Uterosacral suspension. If the uterus has prolapsed outside of the body, or the vagina has prolapsed outside of the body, a doctor may recommend a surgery called a uterosacral suspension.

A uterosacral suspension is performed through the vaginal opening, leaving no visible scars on the outside of the body. If the uterus is still present, a hysterectomy may also be performed during this surgery.

During a uterosacral suspension the vagina is attached to the women’s own uterosacral ligaments using stitches, or sutures. This procedure suspends the vagina back into its original position.
APPENDIX C: PATIENT QUESTIONNAIRES

**Protocol Title:** Educating patients about surgical options for pelvic floor disorders

**Application No.:** NA_00088382

**Principal Investigator:** Victoria Handa, Bayview Medical Center Dept of Ob Gyn A1C Rm 125, 4940 Eastern Avenue Baltimore, MD 21224. (410)550-2787, (410)874-1455

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**Pre-Counseling Patient Questionnaire**

Age:

Race (please circle all that apply):
White, Asian/ Pacific Islander, African American, Hispanic, American Indian, other

Highest completed education level (please circle the best choice):
grade school, high school, some college, college graduate, graduate school

Pelvic floor disorder (please circle all that apply):
cystocele, rectocele, vaginal prolapse, uterine prolapse, enterocele, bladder control problem

How often do you use a smart phone, ipad, or computer? (please circle the best choice):
never, <1/mo, 1/mo, 1/wk, daily

You are discussing surgery for your prolapse. What is your prolapse diagnosis?

What part of your anatomy has prolapsed (please circle all that apply)?
Vagina Uterus/cervix Bladder Rectum Colon Other: Not sure

One option for surgery is to attach mesh from my vagina or cervix to a ligament on the sacrum/backbone.

True False Not sure

One option for surgery is to attach part of my vagina to my sacrospinous ligament.

True False Not sure

One option for surgery is to attach part of my vagina to my uterosacral ligament.

True False Not sure

After surgery, the following will be permanently implanted (please circle all that apply):
Mesh fabric Permanent stitches Wires Screws
Not sure

The surgery will attach my prolapse to (please circle all that apply)
Pubic bone Tailbone Ligament that supports the uterus Pelvic floor muscles Other: Not sure

There is a risk of infection or bleeding with my surgery.

True False Not sure
The bowel, urinary tract, blood vessels or nerves may be injured during the procedure.
   True    False    Not sure
A blood transfusion may have been necessary during my surgery.
   True    False    Not sure
There is a chance my prolapse may come back after my surgery.
   True    False    Not sure
The mesh or sutures used during my surgery are permanent.
   True    False    Not sure
After the surgery, there is a risk that mesh or stitches can come through the vagina (exposure of mesh or stitches).
   True    False    Not sure
What do you wish you knew more about, regarding your diagnosis or treatment?
Post-Counseling Patient Questionnaire

You are discussing surgery for your prolapse. What is your prolapse diagnosis?

What part of your anatomy has prolapsed (please circle all that apply)?

- Vagina
- Uterus/cervix
- Bladder
- Rectum
- Colon
- Other: Not sure

One option for surgery is to attach mesh from my vagina or cervix to a ligament on the sacrum/backbone.

- True
- False
- Not sure

One option for surgery is to attach part of my vagina to my sacrospinous ligament.

- True
- False
- Not sure

One option for surgery is to attach part of my vagina to my uterosacral ligament.

- True
- False
- Not sure

After surgery, the following will be permanently implanted (please circle all that apply):

- Mesh
- Fabric
- Permanent stitches
- Wires
- Screws

- Not sure

The surgery will attach my prolapse to (please circle all that apply)

- Pubic bone
- Tailbone
- Ligament that supports the uterus
- Pelvic floor muscles
- Other: Not sure

There is a risk of infection or bleeding with my surgery.

- True
- False
- Not sure

The bowel, urinary tract, blood vessels or nerves may be injured during the procedure.

- True
- False
- Not sure

A blood transfusion may have been necessary during my surgery.

- True
- False
- Not sure

There is a chance my prolapse may come back after my surgery.

- True
- False
- Not sure

The mesh or sutures used during my surgery are permanent.

- True
- False
- Not sure

After the surgery, there is a risk that mesh or stitches can come through the vagina (exposure of mesh or stitches).

- True
- False
- Not sure

This visual aid helped me understand my condition (please circle the number on the scale).

1 2 3 4 5

- Completely disagree
- Neutral
- Completely agree
This visual aid helped me understand the surgery (please circle the number on the scale).

1  2  3  4  5
Completely disagree  Neutral  Completely agree

What do you wish you knew more about, regarding your diagnosis or treatment?
CITED REFERENCES


http://www.nucleusanimationlibrary.com/animation-preview?animationid=70890

http://www.youtube.com/watch?v=Z4ieA0w7-fM&list=UUbdU9BVyPP0XzGxBtvem8cQ


GENERAL REFERENCES


VITA

Samantha Welker was born on September 23rd, 1988 in Boise, Idaho. She developed a fondness for nature, science, and art while growing up in Idaho. She attended the University of Idaho where she received her Bachelor of Science degree in Biology and a minor in Art.

After graduation she moved to Baltimore, Maryland to pursue a Master of Arts degree in Medical and Biological Illustration from the Johns Hopkins University School of Medicine. During the spring of 2014, Samantha received a Vesalius Trust Research Grant. She will graduate in May of 2014.