11-7-2022

Robot-Assisted Radical Prostatectomy: What to Expect for Your Surgery?

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Robot-Assisted Radical Prostatectomy: What to Expect for Your Surgery?

by
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A Thesis Submitted in Partial Fulfillment of the Requirements for the
Degree of Master of Fine Art in Medical Illustration

School/Department of Medical Sciences, Health, and Management
College of Health Sciences and Technology

Rochester Institute of Technology
Rochester, NY
November 7, 2022

THESIS COMMITTEE APPROVAL

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I. ABSTRACT

Prostate cancer is one of the most common types of cancer, affecting over 191,930 men, with an estimated 34,500 deaths for 2022 in the United States (NIH, 2022). As men age, the risk for prostate cancer increases; about 34% of all men diagnosed with prostate cancer are above the age of 50, and a staggering 70% are over the age of 80. Robot-assisted radical prostatectomy (RARP) is a minimally invasive surgical procedure used to treat clinically localized prostate cancer. In some cases, hydrodissection is used in nerve-sparing surgeries, protecting the neurovascular bundle and ensuring a higher chance of potency for patients. RARP was first introduced in 2000, and in 2009, 70% of radical prostatectomies have been performed with robotic assistance (Elsayed et al., 2021). When compared to open surgery, RARP has shown to have a lower risk of complications, decrease operative times, and improve patient outcomes.

The goal of this project was to provide patients with access to education regarding a complex surgical procedure through the creation of clear, accurate, and aesthetically pleasing visuals within a 2D animation. After viewing this animation, patients will be taught the steps involved in the procedure, and to identify urogenital anatomy. Lastly, this project aimed to reduce patient anxiety surrounding the surgery, resulting in higher lay health literacy, and to instill trust in their healthcare providers.

II. INTRODUCTION

Prostate cancer is one of the deadliest cancers affecting men in the United States. There have been several developments in treating this type of cancer, ranging from chemotherapy, radiation and/or surgical procedures. One of the most common surgical procedures to treat clinically localized prostate cancer is robot-assisted radical prostatectomy, or RARP. RARP involves complete removal of the prostate and surrounding anatomical structures, including the seminal vesicles, from the pelvic cavity. RARP allows for surgeons to perform more precise dissection, and leads to better preservation of functional structures, reduced positive surgical margins, and better perioperative outcomes (Du et al., 2018).

However, from a patient's perspective, the idea of having an organ surgically removed from the body can be daunting. Some patients associate surgery with "loss of control, fear of postoperative pain, and alteration in body image" (Bailey, 2010). One study found that the need for surgery alone increases patient stress and anxiety, no matter the extent of the planned surgical procedure (Bailey, 2010). Typically, it is in the preoperative period where patient anxiety may skyrocket; patients have described the majority of their anxiety stemming from insufficient information, inadequate respect, and insufficient empathy towards healthcare professionals. This results in the patient's family and friends having increased anxiety and less trust in the healthcare system (Bailey, 2010).

The importance of this project was to reduce patient anxiety and increase trust in their doctors and the healthcare system by effectively communicating the necessary information regarding RARP. The creation of an accessible 2D animation demonstrating the correct steps involved in the surgery and accurate representation of urogenital anatomy was the solution.

The primary intended audience of this project was patients undergoing RARP. The secondary audience is friends and family of the patients, as well as the general public. The tertiary audience is healthcare professionals, including doctors, surgeons, nurses, and researchers. It is crucial for patients and their families to have the necessary information regarding RARP. Additionally, healthcare professionals should have access to the animation so that they have the proper toolset to better communicate with current and future patients. Improved communication and distribution of information results in higher health literacy, reduced anxiety, and increased trust between doctor and patient (Bailey, 2010).

To successfully complete this project, there was collaboration and consultation with Dr. Kurshid A. Guru (Dr. Guru), and the entire innovation team of ATLAS Studios at Roswell Park Comprehensive Cancer Center in Buffalo, NY on a weekly basis. Dr. Guru provided scientific feedback on the script and storyboarding process, while the ATLAS Studios team provided art direction and guidance to create each individual illustration asset and animation development.

III. SCIENTIFIC BACKGROUND

A. WHAT IS ROBOT-ASSISTED RADICAL PROSTATECTOMY?

Robot-assisted radical prostatectomy (RARP) is a minimally invasive surgical procedure used to treat clinically localized prostate cancer. The prostate is a walnut shaped gland located inferior to the bladder and produces a white alkaline substance composed of sperm and seminal fluid. In prostate cancer, the acinar cells of the gland undergo anaplasia with extreme atypia, eventually leading to formation of a neoplasm or tumor as the cells proliferate at an accelerated rate (Humphrey, 2017).

Robotic surgery can be described as a surgical procedure that utilizes a camera arm as well as mechanical arms with surgical instruments attached at the ends. The surgeon controls each of the arms while seated at a computer-operated console nearby the operating table. The robot enables the surgeon to have a 3D view of the surgical field with up to 10x magnification. The surgical system used is the Intuitive daVinci® model, allowing surgeons to have increased dexterity and EndoWrist® movements (Mayo Clinic, 2022).

Before its introduction in 2000, the most common surgical methods included open radical prostatectomy (ORP) and laparoscopic radical prostatectomy (LRP). ORP was quickly discontinued as post-operative complications included considerable blood loss, postoperative pain, and a prolonged hospital stay. LRP was then adopted in the early 1990s and became the favorable method as blood loss and postoperative pain decreased, along with shorter hospital stays for patients (Du et al., 2018). As technology advanced, surgeons strived to refine surgical techniques to improve oncological control and provide better postoperative outcomes; thus, RARP was introduced. Studies have shown that RARP reduces blood loss, transfusion rate, and operation time, and lowers the positive surgical margin (PSM) when compared to LRP and ORP.

Most importantly, the "nerve-sparing, recovery of complete urinary continence, and recovery of erectile function rates" were higher for RARP than LRP and ORP (Du et al., 2018).

As RARP became the preferred method for prostate cancer treatment, improvements to nerve-sparing techniques began to develop. During nerve-sparing RARP, the neurovascular bundle surrounding the prostate is preserved and left within the pelvic cavity. The neurovascular bundle is a complex entanglement of nerves and small arteries within the pedicle of the prostate, located posterolaterally and symmetrically to the gland in the space defined by the levator fascia, prostatic fascia, and Denonvilliers' fascia (Park et al., 2013). These hypogastric nerves are responsible for erectile function, and ultimately potency.

First introduced in 1987, hydrodissection is an athermic nerve-sparing technique that separates normal tumors from normal brain tissue (Guru et al., 2008). It was historically used in neurosurgery, plastic surgery, and general surgery, all with relative success. Surgeons then began to adapt the technique to retroperitoneal lymph node dissection to separate nodes away from larger blood vessels and sympathetic nerves. A collaborative effort from the researchers at Roswell Park Comprehensive Cancer Center, State University of New York at Buffalo, and Henry Ford Hospital then applied the technique to robot-assisted radical prostatectomy. The goal of hydrodissection was not only to achieve a negative surgical margin, but to completely preserve the neurovascular bundle surrounding the prostate intact. (Guru et al., 2008).

During hydrodissection, a cannula needle is inserted into the prostatic pedicle, injecting a solution of saline and epinephrine. Epinephrine is used to minimize bleeding, thereby improving visualization of the pedicle. Guru, et al (2008) describe the specifics of how hydrodissection improves visual accuracy for surgeons:

> Injection results in expansion of the space between the prostate capsule and the neurovascular bundle, creating a fluid curtain around the vessels in the pedicle.

> Hydrostatic pressures generated from hydrodissection push the neurovascular bundle away from the prostate capsule along natural tissue planes. A grasper is used to gently spread in the space between the prostatic capsule and the neurovascular bundle along the vessels, without using cautery. This maneuver helps identify individual vessels entering into the prostate, which are clipped with 5 mm hemo-lock clips. Once the pedicle is released at the base of the prostate, further dissection is performed by simply pushing the tissue away from the posterolateral surface of the prostate (p. 2).

Not all surgeons may utilize this technique, but it should be noted that the absence of electrocautery and thermal dissection of the neurovascular bundle demonstrates significant improvements in potency and sexual function. Thus, hydrodissection is an acceptable, athermic method for preservation of the neurovascular bundle (Guru et al., 2008).

IV. BODY OF WORK

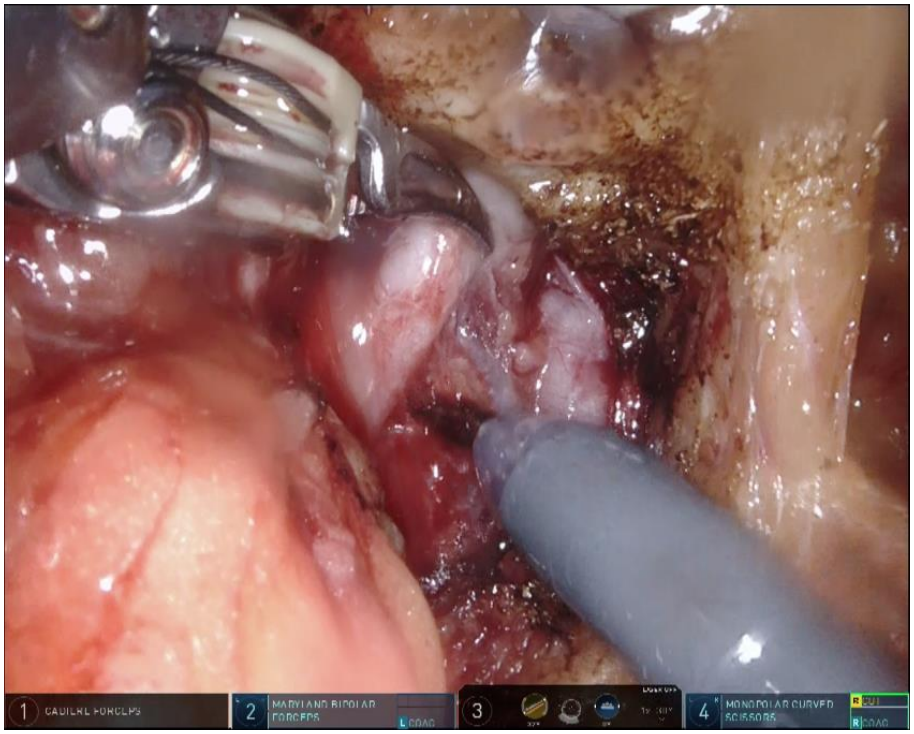
A. GOALS

The overall aim of this thesis project was to create a 2D animation depicting the surgical steps involved in a nerve-sparing robot-assisted radical prostatectomy, geared towards a lay patient audience. The major goals were to:

1. Create clear, accurate, and aesthetically pleasing visuals when learning about a complex surgical procedure
2. Maximize accessibility for patients to view the animation by posting on their private Patient Portal, as well as the public Roswell Park Urology YouTube channel
3. Generally reduce fear of the surgical procedure
4. Easily identify pelvic and urogenital anatomy

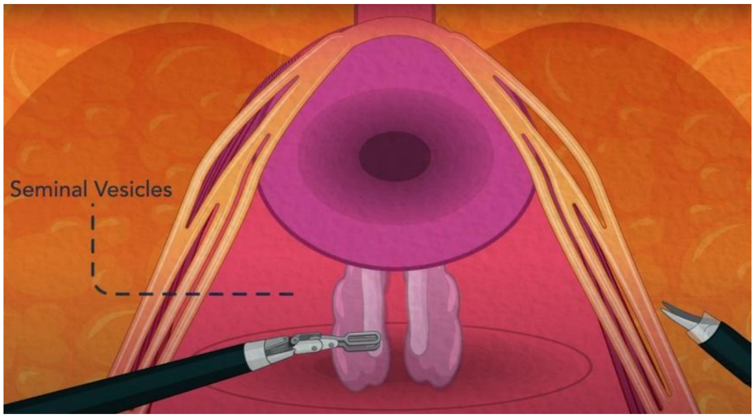
B. ILLUSTRATION PROCESS

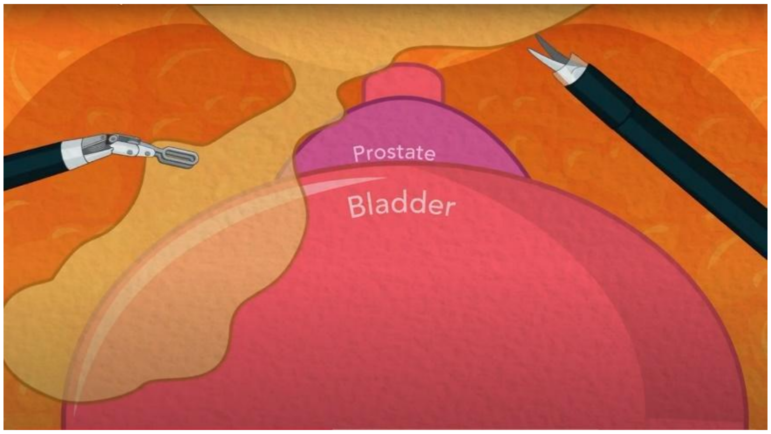
Surgical footage of RARP was provided to me by ATLAS Studios as a reference for the illustration process. The footage contained no labels nor narration, and the anatomy appeared as similarly colored reds, pinks, and yellows. Wet, squishy textures can be seen throughout the footage, making it difficult to discern the boundaries of anatomic structures. To further the distortion, the surgical field of view is both backwards and upside down when compared to standard anatomical position. This is how the anatomy appears in the reality of the surgery, and thus, the features are not easily distinguishable from each other. To a viewer without extensive anatomical and medical education, this would be incredibly difficult to make clear the exact steps occurring; it might also cause queasiness to the viewer to see internal organs cut and bleeding. Working alongside Dr. Guru and ATLAS Studios, I was taught to orient myself to the surgical field of view as each step was carefully explained to me. As a medical illustrator, it was my purpose to use my background knowledge and training in anatomy to render and interpret each key moment of the procedure in a way that was clear, accurate, and visually pleasing.

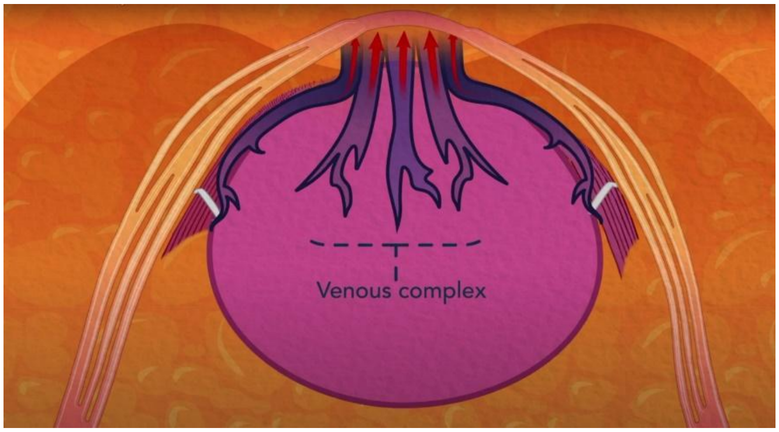


The animation and illustrations were chosen to be completed in 2D as opposed to 3D rendering, which was unnecessary for this project. 2D illustrations not only allowed me to maintain clarity and accuracy, but also granted me creative freedom and stylistic choices based on the audience. The dissemination of the surgical process needed to be factual, not obscure any of the critical details the target audience must be aware of, and be clear of my own personal emotions (Botsis et al., 2020). Initially, the illustrations were created in a flat, vector style in Adobe Illustrator. The bright, over-stylized design gave the impression of a friendlier, more playful feeling. My goal was to eradicate any fear or disgust that the viewer might have when watching internal organs get cut and removed, so I went in what I interpreted as the complete opposite direction. The incorporation of components that reduce stress, eliminate doubts, and boost interest are some of the right strategies when it comes to designing for a lay audience

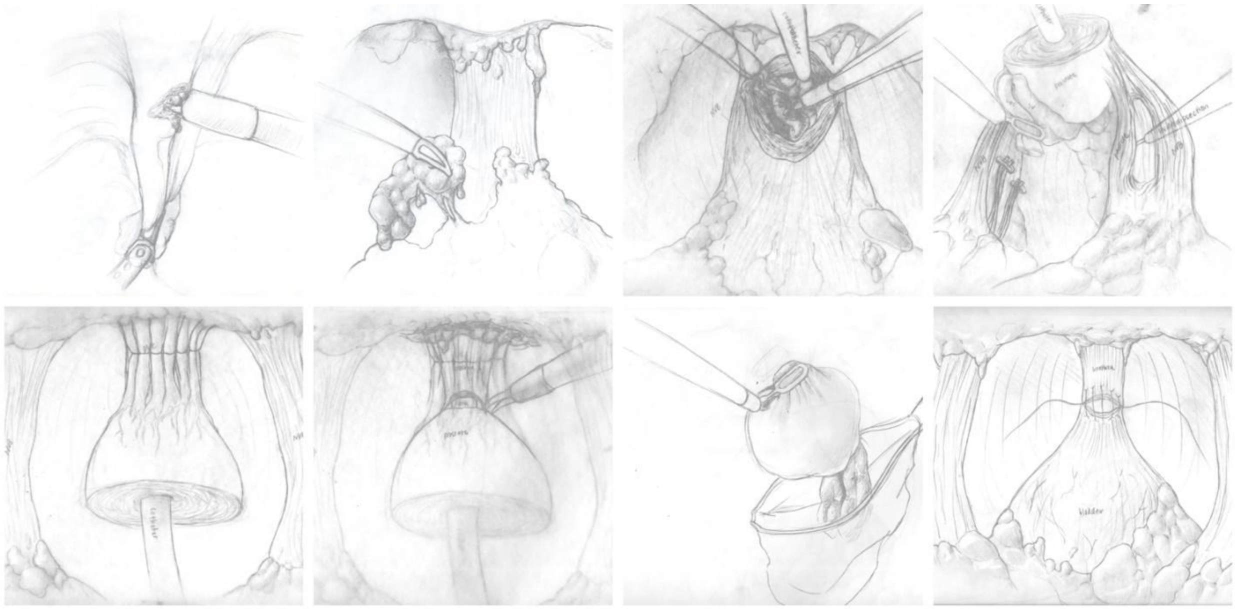
(Botsis et al., 2020). I also opted for vector illustrations as they would be easier to manipulate in Adobe After Effects, which is the program used for creating the final animation.



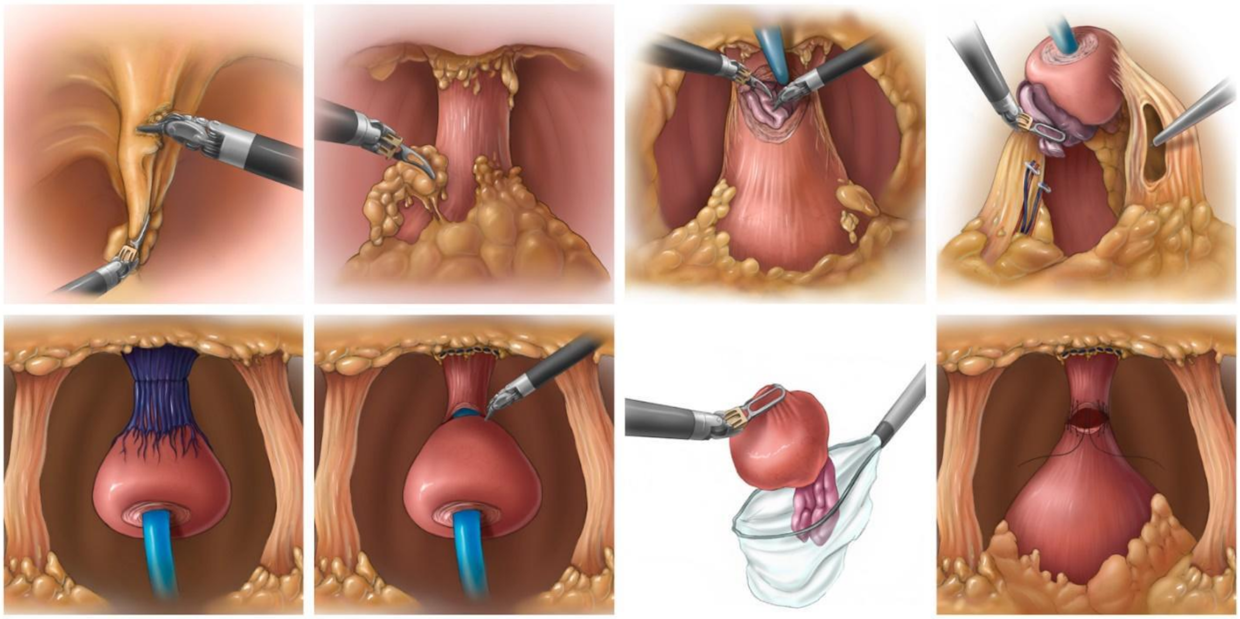




Eventually, I altered the style of illustration to have a hand-drawn and painterly appearance, creating a more realistic effect. Preserving accuracy of the anatomy and the surgical procedure was critical to this project, but it was unfortunately lost in the flat style. The focus was placed more on aesthetics rather than efficiency. The incorporation of many decorative components or the sole focus on the originality aspect may speak to the audience's emotions, however, blur the scientific information; the credibility of the story may be also affected (Botsis et al., 2020). My content advisors and I agreed that the flat illustration style did not suit the audience. At first, bright colors and simpler rendering techniques seemed the best choice given that the project targeted a lay patient audience; however, as the animation progressed, it seemed to be too playful and juvenile, given the severe subject matter and this particular elderly audience. A softer, more dimensional illustration style was deemed as more appropriate. Understanding the target audience is a complex process and pertains to the evaluation of various factors, including health literacy and numeracy as well as demographic and psychosocial parameters (Botsis et al., 2020). The illustrations of the pelvic anatomy and surgical instruments were first recreated by pencil on paper, then digitally scanned and rendered in a raster-based program, Procreate. I made minor adjustments to the characters for consistency with the re-drawn assets. Modifying the assets to be more illustrative also meant the level of complexity, or detail, increased.



A less complex illustration would include less details, less realistic rendering, and overall, less information to be taken in by the viewer; by contrast, a more complex illustration naturally would include more detail, and more realistic rendering and shading. It was pertinent to establish which bits of information and details to include to maximize clarity and accuracy but also to avoid overwhelming the viewer. The original stylized illustrations were not complex, and thus the intentions of the animation were not made clear. Once the illustration style changed to be more meticulous and complex, the information was communicated effectively and articulately.



C. ANIMATION PROCESS

1. SCRIPT

The animation process for my thesis project required a significant amount of planning and preparation. Before animation could commence, a script, voice narration, and storyboards were developed. The script acted as an initial outline of the animation, and the exact verbiage to be spoken by the narrator. I wrote an initial draft of a script that would be later revised by my content advisors at ATLAS. Experts in the patient education department of Roswell Park then finalized the script (see Appendix) to ensure it contained the appropriate language for my intended audience.

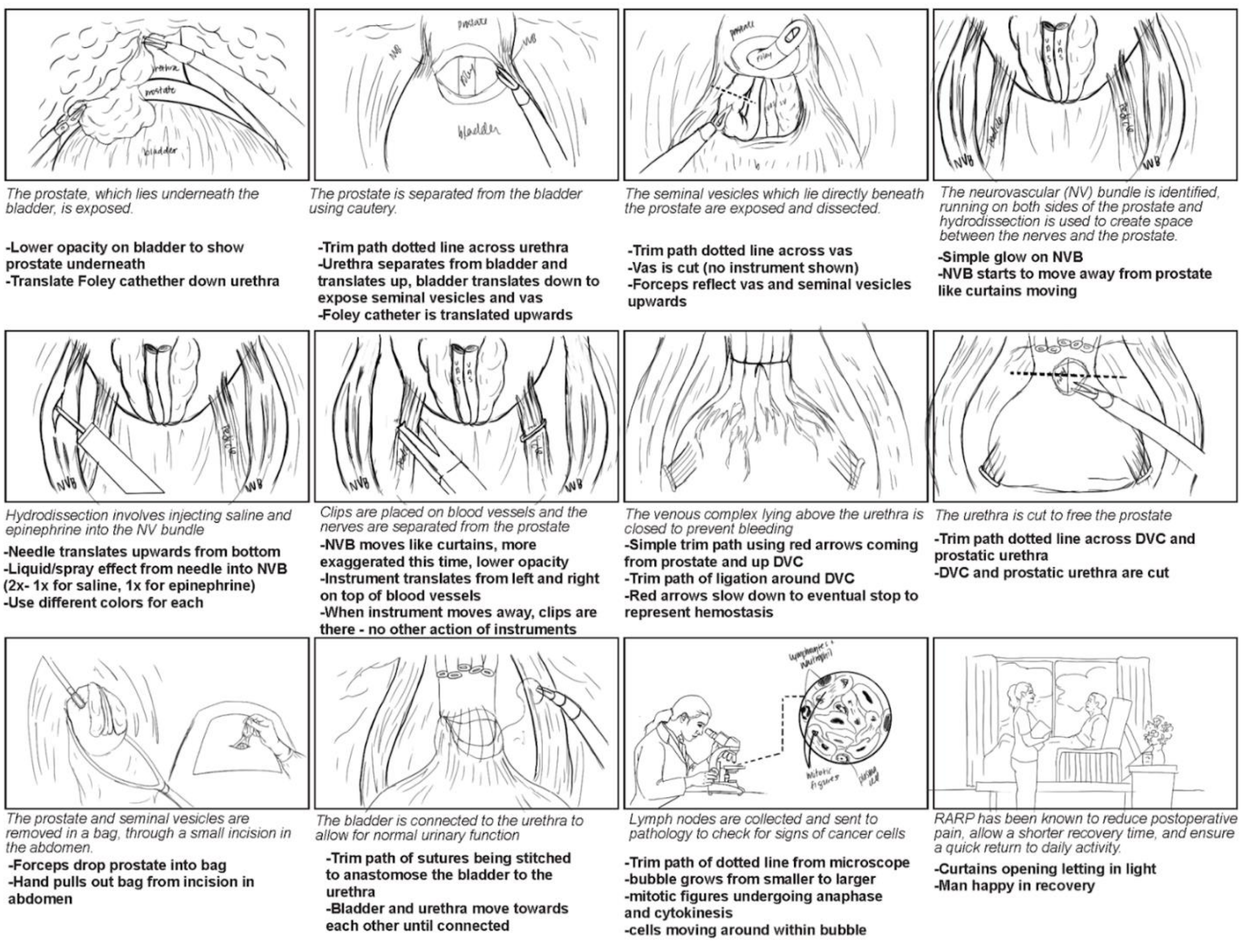
2. NARRATION

Once the written script was approved, voice recordings for the narration took place. The voice narration was professionally recorded and provided by ATLAS Studios. Once received, the .wav files were imported into the After Effects file. The finalized animation was then exported to Adobe Premiere where captions and subtitles could be added. This increased the accessibility of the animation to hard-of-hearing and deaf viewers so they may follow along with ease.

3. STORYBOARDS

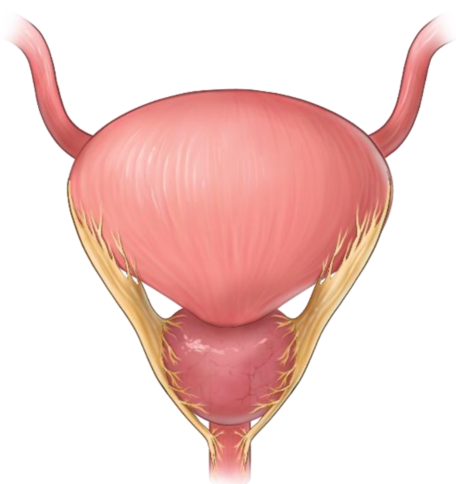
Storyboarding is a process of laying out ideas for visuals and cues that my content advisors could refer to when making edits. It also serves as a visual outline of the full animation. The main challenges I discovered during the storyboarding process included compressing a multi-hour complex surgery into a three minute animation, and orienting the viewer from the standard anatomic position to the surgical field of view. The first challenge was addressed in collaboration with Dr. Guru. Together, we specified the exact steps needed to be included to preserve accuracy, but ensure competency. The second challenge was resolved with the ATLAS team by showing the patient moving into the Trendelenburg surgical position from both the lateral and axial planes. By including both angles, the viewer could seamlessly orient themselves from the standard anatomic position to the surgical field of view.

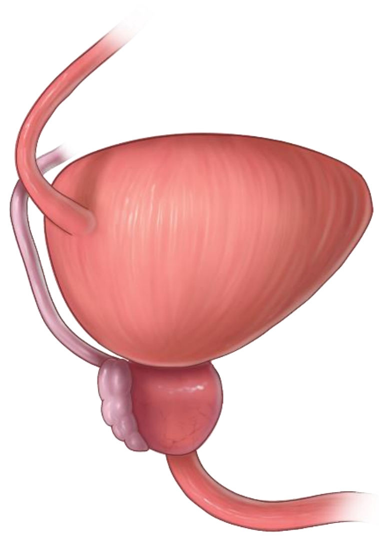
The storyboards consisted of a page of twelve rectangles based on a 16:9 ratio. Each page would add up to about 60 seconds of content. By the end of the storyboarding process, there were two pages of storyboards, which adds up to about 120 seconds of animation to create. With an introductory title screen and a final screen with citations and credits, the full animation totaled to 2 minutes and 45 seconds.

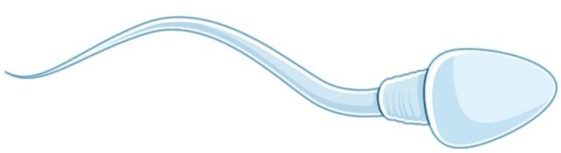


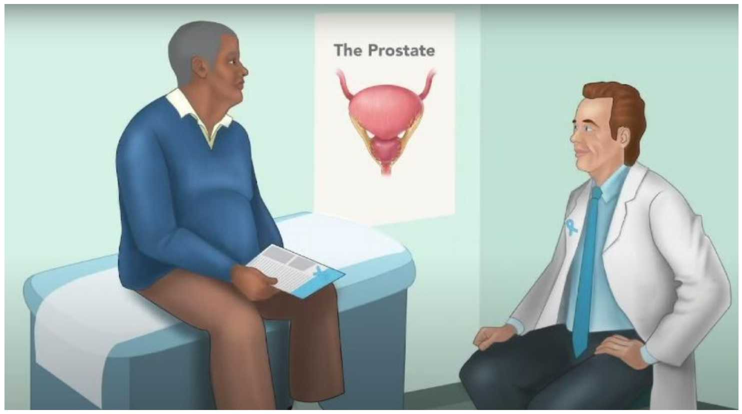
4. ASSETS

The illustrations I developed acted as my assets to animate once imported into After Effects. The assets I created included a patient, urologist, pathologist, and nurse; pelvic anatomy, including the pelvic cavity, the bladder with both ureters, the prostate, the vas deferens, the neurovascular bundle (NVB), and the seminal vesicles; cellular components, including sperm, cancer cells, and various leukocytes; medical devices, including the daVinci® Robotic Surgical System and the instrumental heads, including Maryland bipolar forceps, prograsp forceps, monopolar curved scissors, needle driver, clip applicator, and specimen bag.





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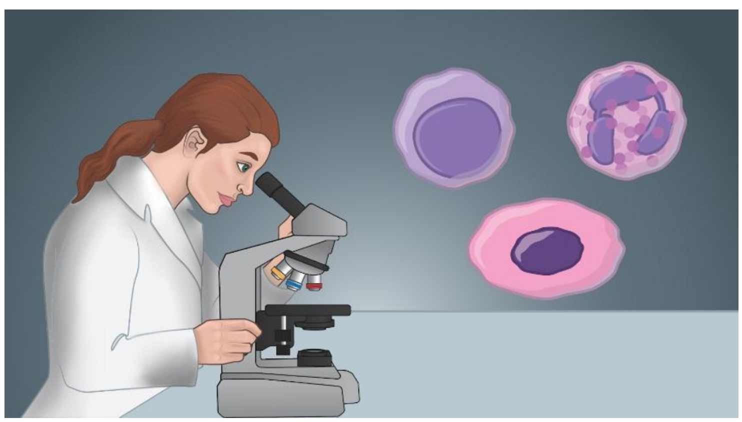
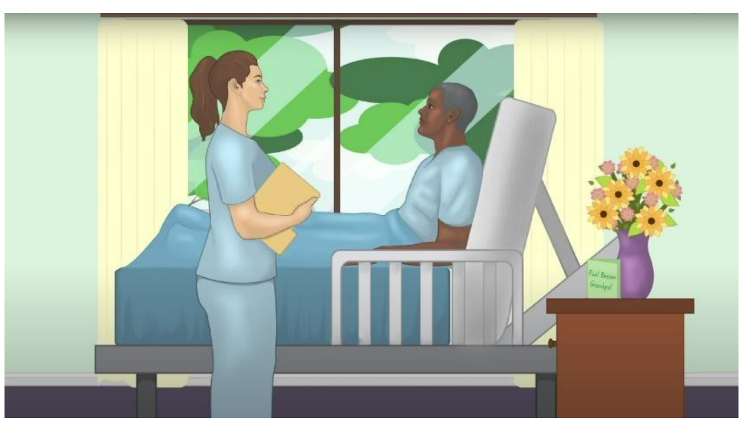
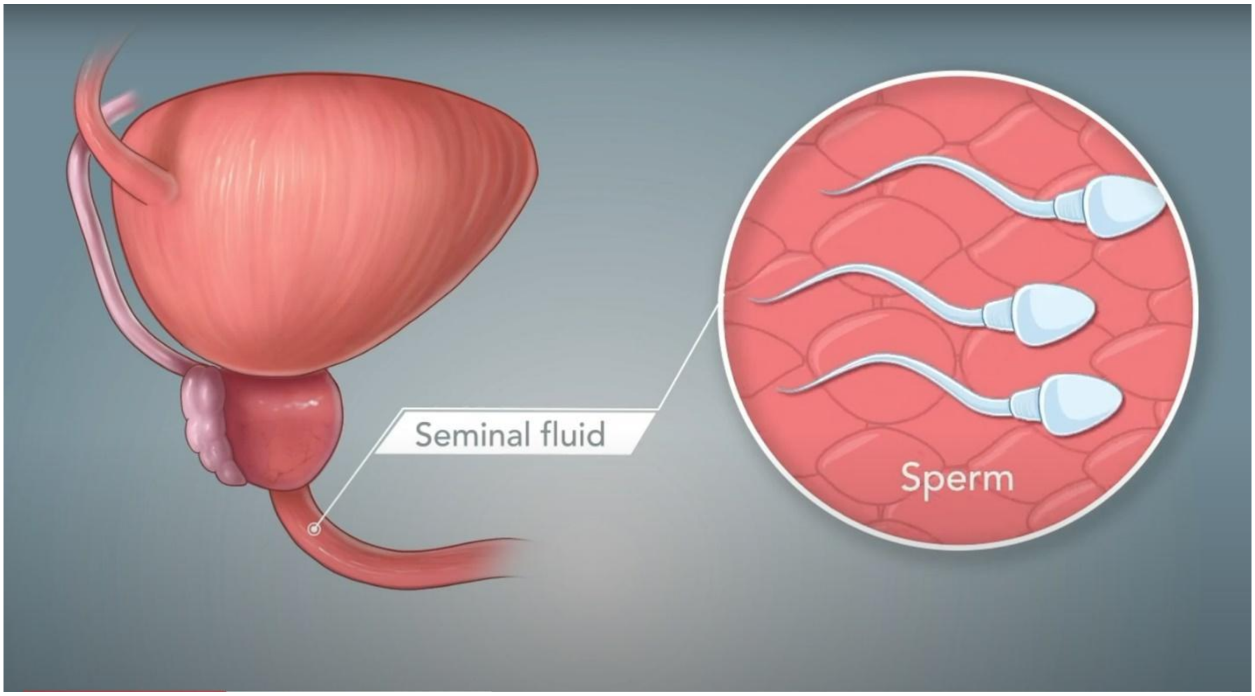




5. ANIMATION

Once the illustrative assets were completed, I imported them to be composed into an animation using Adobe After Effects. Dr. Guru and I broke down the surgical procedure into a total of eight main steps, a much simpler, less complicated version when compared to reality. Fewer steps shortened the length of the animation, thus holding the viewer's attention for longer. From there, I organized the introductory scenes, surgical procedure, concluding scenes, and credits into 20 pre-compositions. This was done to maximize organization within the program, which made for a more manageable animation process. Fades and wipes were the most utilized transitions between scenes. Opacity layers and masks were often used, especially in instances of growing and shrinking anatomical features in and out of view, and to trick the eye into believing the sperm were moving throughout the urethra as shown here:



There was also an intention to limit the amount of text on the screen. The focus was to have the assets and animation speak for themselves. If too much text was used in the animation, the animation would become obsolete (Botsis et al., 2020). I opted to only include text on-screen when defining specific terminology, such as “nerve-sparing surgery” and “hydrodissection,” as well as when the orientation changed, like the transition from standard anatomical position to the surgical field, and removal of the prostate and associated organs from the pelvic cavity. Only certain keywords within the bodies of text were bolded so they stood out more to the viewer. Labels were the only other text necessary to include, as it was one of the major goals to have viewers easily learn to identify the anatomical structures. The labels were also carefully designed in a futuristic style to be visually interesting, but not distracting to the illustrative assets: the main teaching elements. All the text was magnified to a larger font size to increase legibility. Lastly, the text was gradually faded in and out to give the viewer time to read and process the written information.

6. MUSIC

The ambient music used in this thesis project was accessed through Bensound.com. The goal was to find music that was both calming but also upbeat to maintain the viewer’s attention without being too distracting.

V. CONCLUSION

Prostate cancer is a deadly disease affecting a large percentage of the male population. It is vitally important that not only healthcare professionals, such as doctors, nurses, and researchers have the adequate materials to study this disease, but that the patients and the lay public also have access to learning about it. Visual aids are crucial to ensure the highest means of health literacy among a vast audience. If patients can correctly identify urogenital anatomy, become familiar with the methodology of RARP, resulting in less anxiety and fear of their upcoming surgery, then that would be a measure of success of the animation.

I am curious about other advancements and modifications of this procedure, and how it would impact the outcomes of past, current, and future patients. Once more surgeons adopt RARP as the standard for radical prostatectomy, will patients have lower positive surgical margins? Could there be improvements for men to maintain their potency and sexual function? Would patients find their healthcare providers to be more trustworthy, feeling more comfortable about their upcoming surgery?

Additionally, I'd like to continue learning and improving my animation skills. Before this project, I had no prior knowledge of Adobe After Effects. I always enjoy a challenge, and it would be an understatement to say this was no easy feat. As I progress my skills, and receive feedback from patients and healthcare professionals, I'd be intrigued to see what I would change or do differently to ensure better health literacy results.

Overall, I have found this project to be incredibly rewarding. Speaking from personal experience, a number of family members have been afflicted by cancer. If they had access to an animation or other visuals that could have assisted in their education about their disease, I think it would have eased their worries. I hope that this RARP animation will help others experiencing prostate cancer.

I would like to extend my gratitude to my colleagues at The ATLAS Program at Roswell Park Comprehensive Cancer Center. Without their guidance and expertise, this project would not have been possible. I can only hope to continue working with the team in the future.

VI. APPENDIX

A. SCRIPT

Prostate cancer is one of the most common types of cancer in men. The prostate is a male reproductive gland located within the pelvis underneath the bladder. This walnut shaped gland produces white, alkaline seminal fluid, a component that nourishes and transports sperm in semen.

Radical prostatectomy remains the most common treatment for clinically localized prostate cancer. In some cases, nerve-sparing surgery can be done. This type of surgery will preserve the nerves responsible for erectile function.

First, the patient is positioned in a steep Trendelenburg. Six ports are placed in the abdomen allowing the surgeon to gain access to the pelvic cavity.

The prostate, which lies underneath the bladder, is exposed. The prostate is separated from the bladder using cautery. The seminal vesicles which lie directly beneath the prostate are exposed and dissected. The neurovascular (NV) bundle is identified, running on both sides of the prostate and hydrodissection is used to create space between the nerves and the prostate. Hydrodissection involves injecting saline and epinephrine into the NV bundle. Clips are placed on blood vessels and the nerves are separated from the prostate. The venous complex lying above the urethra is closed to prevent bleeding. The urethra is cut to free the prostate. The prostate and seminal vesicles are removed in a bag, through a small incision in the abdomen. The bladder is connected to the urethra to allow for normal urinary function. Lymph nodes are collected and sent to pathology to check for signs of cancer cells.

RARP has been known to reduce postoperative pain, allow a shorter recovery time, and ensure a quick return to daily activity.

VII. REFERENCES

1. National Cancer Institute Surveillance, Epidemiology, and End Results Program (SEER). (n.d.). *Cancer of the prostate - cancer stat facts*. Retrieved May 26, 2022, from https://seer.cancer.gov/statfacts/html/prost.html

2. Bailey, L. (2010). Strategies for Decreasing Patient Anxiety in the Perioperative Setting. *AORN Journal*, *92*(4), 445–460. https://doi.org/10.1016/j.aorn.2010.04.017

3. Botsis, T., Fairman, J. E., Moran, M. B., & Anagnostou, V. (2020). Visual storytelling enhances knowledge dissemination in biomedical science. *Journal of Biomedical Informatics*, *107*, 103458. https://doi.org/10.1016/j.jbi.2020.103458

4. Du, Y., Long, Q., Guan, B., Mu, L., Tian, J., Jiang, Y., Bai, X., & Wu, D. (2018). Robot-Assisted Radical Prostatectomy Is More Beneficial for Prostate Cancer Patients: A System Review and Meta-Analysis. *Medical Science Monitor*, *24*, 272–287. https://doi.org/10.12659/msm.907092

5. Elsayed, A. S., Ely, H. B., Abdelhakim, M. A., Saad, I. R., Jing, Z., Iqbal, U., Ramahi, Y., Joseph, J., Houenstein, H., James, G., Peabody, J. O., Razzak, O. A., Hussein, A., & Guru, K. A. (2022). Preservation of endopelvic fascia, puboprostatic ligaments, dorsal venous complex and hydrodissection of the neurovascular bundles during robot-assisted radical prostatectomy: a video demonstration and propensity score matched outcomes. *Urology Video Journal*, *14*, 100143. https://doi.org/10.1016/j.urolvj.2022.100143

6. Guru, K. A., Perlmutter, A. E., Butt, Z. M., & Peabody, J. O. (2008). Hydrodissection for preservation of neurovascular bundle during robot-assisted radical prostatectomy. *The Canadian Journal of Urology*, *15*(2), 4000–4003.

7. Humphrey, P. A. (2017). Histopathology of Prostate Cancer. *Cold Spring Harbor Perspectives in Medicine*, *7*(10). https://doi.org/10.1101/cshperspect.a030411

8. Park, Y. H., Jeong, C. W., & Lee, S. E. (2013). A comprehensive review of neuroanatomy of the prostate. *Prostate International*, *1*(4), 1–7. https://doi.org/10.12954/pi.13020

9. *Robotic surgery - Mayo Clinic*. (2022, May 6). Retrieved June 1, 2022, from https://www.mayoclinic.org/tests-procedures/robotic-surgery/about/pac-20394974