Spark Tank Grant

3D Cervical and Lumbar Models for Epidural Placement Training

Spark Tank Grant 501-620

Zachary Headman, OMS-II

Marcus Matson, OMS-II

Debra Loguda-Summers, CLSS

Public Services & 3D Print Services Manager

A.T. Still Memorial Library

08.17.2018

Spark Tank Grant
3D Cervical and Lumbar Models for Epidural Placement Training

1. Describe your project:

There is a great need in medical education for less expensive, lifelike injection training models. Our project fills this gap, by allowing students an opportunity to practice performing various injections in 3D printed, anatomically correct, lifelike models. Originally, our proposal consisted of ballistic gel encased cervical and lumbar model production, but expanded to include ballistic gel pelvis models as well.

These 3D printed cervical, lumbar, and pelvis models, allow faculty to teach students numerous injection procedures in a safe environment. Through repetitive practice, this product allows students to develop the muscle memory needed to become more confident when attempting injections on real patients. Our models also have the benefit of being ultrasound compatible. This allows students to not only learn and perfect various injection procedures, but can be a useful tool in the ATSU Ultrasound department. All incoming students will have the opportunity to perfect their procedural abilities and anatomical understanding with a real-time imaging system. We believe that these models will help produce more effective physicians, and most importantly, better patient outcomes.

2. Explain how you conducted your project:

There were many people closely involved in the production, without whom, this project would not have been possible. The development of this project was through much trial and error.

Zachary Headman, OMS-II, Marcus Matson, OMS-II, and Debra Loguda-Summers, Public Service & 3D Print Service Manager, assumed the roles as the primary developers/investigators. They were responsible for the project development and production of the models. Debra, the 3D print service manager at the A.T. Still Memorial Library (ATSML), was responsible for most of the 3D printing for this project. Additionally, she managed the grant funds and account.

Jamie Carroll, Senior Graphic Artist, Academic Technologies, ATSU, was involved as our graphic designer. He helped to modify 3D files as needed and created new files such as the lumbar and cervical discs, nerves, and vascular pieces needed to recreate the anatomical models. He also assisted in printing prototypes of the new 3D files as well.

James Potter, DO, Robert Schneider, DO, and Tatyana Kondrashova, MD, PhD, were utilized as expert consultants to assist in making the models as lifelike as possible. Being experts in their fields, anesthesiology, family medicine, and medical imaging, respectively, they helped ensure that the models would be constructed in a way to maximize their value. Additionally, as attending physicians, they will utilize these models to help train the resident physicians over whom they have responsibility. This also allowed us the ability to utilize their current residents in the research projects that came from this project, which are discussed later.

The project developed and evolved over weeks and months as proposed ideas were tested and modified.

3D printing: the goal was to utilize the 3D printing resources at ATSML to print lifelike models of the cervical spine, lumbar spine, and pelvis (sacrum and innominates). The files required for printing were attained through free open source files from thinkgiverse.com as well as files created by Jamie Carroll. All files were test printed and modified to ensure a lifelike size and proper orientation. This 3D process was used to print all needed bones, intervertebral discs, blood vessels, nerves, and accessory pieces such as a stand. Debra was responsible for printing any/all large hard pieces, (i.e. bones.) Jamie used his specialized 3D printer to print any/all small soft pieces, (i.e. intervertebral discs, blood vessels, and nerves.)

Model assembly: once the bones were printed, they were assembled together using gorilla glue gel and small screws. Screws were used in an alternating left to right or front to back pattern as well as glued in all the spaces to ensure longevity of the models. The printed nerves, vasculature, and rubber tubing (representing the spinal cord) were placed in their proper anatomical position. Some of the models were then coated with a high temperature silicone in an effort to minimize the cavitation/bubble, which will be discussed later. The models were then attached with screws to a wooden stand to support them in the proper position.

Ballistics gel: in order to encase each model in ballistics gel. Molds were handcrafted using aluminum sheet metal and flue pipe to ensure the proper shape and size for each model was to the specification required. The molds were attached around the models and wooden bases with high temperature fireplace sealant, flue tape, and steel duct clamps to insure that the hot liquid ballistics gel did not leak. The ballistics gel was cut into small pieces and melted in three-pound increments in a turkey roaster and oven (for the larger pours) at 250 degrees F. Once melted to its liquid form it was then poured into each mold and allowed to cool.* Once the gel cooled and solidified, an electric heated knife and hot air gun was used to sculpt the molds into their proper anatomical human form.

* Several attempts were made to determine the cooling down process of the models to avoid bubbles. The additional directions suggestion to pour the hot liquid gel into the molds and then place back into the oven to cool for 12 hours. This process would only work if the models fit into an oven, which the larger models did not. It also did not cease the issue we were having with bubbles in the ballistics gel. We decided instead of a slow cool down in an oven to pour the gel into the molds in sections and let them cool down outside the oven. It made a slight difference in the bubbles and helped speed up the wait time between pours, since the roaster and/or oven was free to melt more gel.
Consulting with the ballistic gel company and others, we tested several theories on how to cut down on the bubbles in the gel due to the 3D models. So far, nothing has really worked except patience and working with the liquid gel as it cooled. It was discovered that the hard 3D material used to print the bones was causing the issues. More testing is to be done by Debra at a later day to see if this issue can be resolved. Nevertheless, at this time Drs. Potter, Schneider, and Kondrashova are happy with the models and are putting them to use.

Injection testing: each model was then presented to physicians to assess anatomical accuracy and ease of use as a training model. The cervical model was found to be effective for different types facet injections and nerve blocks. The lumbar models served two different purposes; one model was made into an epidural training model and was found to be an accurate model for epidural training purposes; the second lumbar model was designed as a lumbar puncture training model. It was effective in helping students to learn proper technique and is able to provide realistic feedback through fluid collection mimicking a true lumbar puncture. The pelvic model was evaluated and found to be effective for multiple injections at various sites in the pelvis. A unique benefit that was recognized in all the models was the fact that the ballistics gel is translucent. This feature allows students to have a realistic view of the anatomy and gain a better understanding of procedures and the proper placement for effective injections. Due to the ballistics gel being transparent, each student is able to view the needle as it is guided into the proper location. This visualization helps to create an effective visual and mechanical learning experience by associating the proper anatomy while performing the procedure. The models have the ability to be used with ultrasound, which will allow the students the ability to learn a new procedure, but practice the skills they already have learned from ATSUs ultrasound curriculum.

3. Describe what you have learned:

The opportunity to work on a project revolving around 3D printing has given us greater insight to the promising future that 3D printing holds in advancing the medical field. The ability to create a 3D structure from a predesigned computer files, CAT scan, and MRIs has already, and will continue to open up many new ground breaking avenues as time continues. As medical students and resident physicians pursue continued medical education, affordable, life-like models created from 3D printing can fill that need.

These models are already being put to use in multiple research projects at ATSU/KCOM with the help of our spark tank team as well as the faculty there. The research projects studied are to determine the effectiveness of our models in resident and medical student injection training. We are well underway in these projects and are working on data collection, and hope to have multiple papers published within the year in journals such as Journal of the American Osteopathic Association (JAOA.) This will not only allow our project to be seen by thousands of medical professionals across the country but will hopefully be a source of ongoing research and learning for future medical professionals and staff here at ATSU.

4. Provide your recommendations for how it could be used in the future regarding wider distribution; or future adapted used of your project:

Our goal is that our models be adapted into the current curriculum in departments such as ultrasound, OMM, and surgery. Once the efficacy of these models has been seen and tested by the staff and students, our hopes are that our processes and knowledge gained from creating these models can be put to further use with the creation of new models such as shoulder, hip and knee joints for more injection training and example models of common somatic dysfunction that allow the students to see what they should be feeling to accelerate their learning of OMM. They also can be used in further research projects as we learn more about the models and their effective uses from the research we are currently undertaking.

5. Other:

The Spark Tank team of Zachary Headman, Marcus Matson, and Debra Loguda Summers are working with ATSU legal counsel at this time to research the opportunity of patenting this 3D model design. We would like to thank President Phelps, the judges, and the A.T. Still University Teaching & Learning Center for making this project possible. We hope that this will enhance the training of our medical and dental students in the future.