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Education

A Simplified Abdominal Wall Model to Teach Complex Abdominal Wall Reconstruction

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Summary: A simplified and functional abdominal wall model is necessary for surgical education. The utility of such a model encompasses medical student, resident, and fellow education. This is especially relevant in the fields of general surgery and plastic surgery. An abdominal wall model helps with a more complete understanding of abdomen access, hernia repair, and complex abdominal wall reconstruction. Although several models have been proposed, they are expensive and limitations exist due to access, costly repairs, maintenance, and part replacements. There is currently no consensus or widely adopted model used in surgical training programs. We present a simplified abdominal wall model that is inexpensive and easily reproducible. *(Plast Reconstr Surg Glob Open 2022;10:e4322; doi: 10.1097/GOX.0000000000004322; Published online 13 May 2022.)*

A proficient understanding of the abdominal wall is a foundational component of surgical education for medical students and residents. Anatomy is often learned with the aid of textbooks,[1] cadaver dissections,[2] virtual models,[3] and intraoperative teaching.[4] In order for learners to perform at their best, it is necessary to have a functional understanding of the layers of the abdominal wall and their relationships to one another. This is imperative for laparotomy closure, standard hernia repairs, abdominoplasties, panniculectomies, and complex abdominal wall reconstructions.

Although a functional model of the abdominal wall is necessary for education, there is not currently an accepted gold standard being used in surgical residencies. A few publications have proposed different educational models used for laparotomy closure and hernia repair.[5] They include animal models,[6] synthetic models (such as the "AbdoMAN"[7] and The CLOS-IT system[8]), and virtual reality models.[9] The cost of these models range from hundreds to thousands of dollars. This is a barrier to education that can be overcome.

There is a need for a simplified, easily accessible, inexpensive, low technology, and easily reproducible abdominal wall model. We have found that assembling the pieces of our model has as much utility in education as using the constructed model itself. This is due to the three-dimensional reasoning required to visualize which layers are laid upon one another and their relative location to each other within the abdominal wall. To construct the model, several pieces of felt squares are used that are the size of a normal piece of printer paper. If one wanted to demonstrate the entire abdominal wall in one model, then the model presented here could be modified with a transversalis muscle layer that began more medially in the superior direction and receded to a more lateral position as it proceeded inferiorly.[10] The model we demonstrate here represents a cross section of the middle of the abdominal wall. Of note, we chose to use different color felt squares to represent the different components of the abdominal wall. The total cost of materials to construct one model (including seven squares of felt and a plastic sheet to represent mesh) was less than $9 at a local crafts store.

The model is constructed starting from the peritoneum layer to the skin (in a posterior-to-anterior direction). The construction begins by laying down the first square on a flat surface. This represents the peritoneum. A second felt square of a different color should be cut into thirds. One of these is laid on each side of the previous layer. These represent the transversus abdominis layers lying laterally. Next, the rectus muscles and fascia are constructed. To do

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this, a dark piece of felt is cut into four segments. Two of them are used (one for each side). To create one side, one piece is placed in the middle of another piece of lighter colored felt, which is then folded over to represent the fascial covering over the rectus muscle. Two of these units are made and placed on the existing model to represent the bilateral rectus muscles with their respective anterior and posterior rectus sheaths. The external and internal oblique muscles are represented by the extensions from this unit past the lateral aspect of the confluence of the rectus sheaths. These lay directly anterior to the transversalis muscle laterally. Another piece of felt is then placed on top of this layer to represent the subcutaneous fat and Scarpa layer. A final piece is placed on top (in the most anterior location) to represent the skin layer. Viewing this model from the side, one can observe the different layers of the abdominal wall and their relationships to one another (Fig. 1). Figure 2 provides a more detailed side view of one side of the abdominal wall model.

Once the model is constructed, it can be used to study anatomic relationships (Figs. 1, 2). It can also be used to make incisions and understand how different abdominal wall reconstructions are performed. For medical students and junior residents, it is educational to simply demonstrate and assist them through the step-by-step process of a midline laparotomy or placing mesh in specific locations. All types of hernia repairs can be simulated by this model. It is to be noted that this model is intended to be a simplified model to demonstrate anatomic relationships and should not be used as a substitute for teaching precise surgical maneuvers with real human tissue.

Takeaways

Question: Is there a simple, inexpensive abdominal wall model that can be used for surgical education?

Findings: We present a simple abdominal wall model that can be used in surgical education for a functional understanding of abdominal wall anatomy, hernia repair, and complex abdominal wall reconstruction.

Meaning: This article demonstrates a simplified, globally accessible, inexpensive, low technology, and easily reproducible abdominal wall model for surgical education.

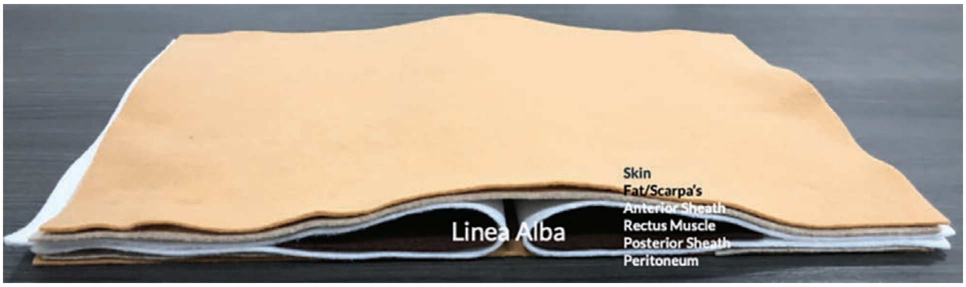

Fig. 1. Completed abdominal wall model.

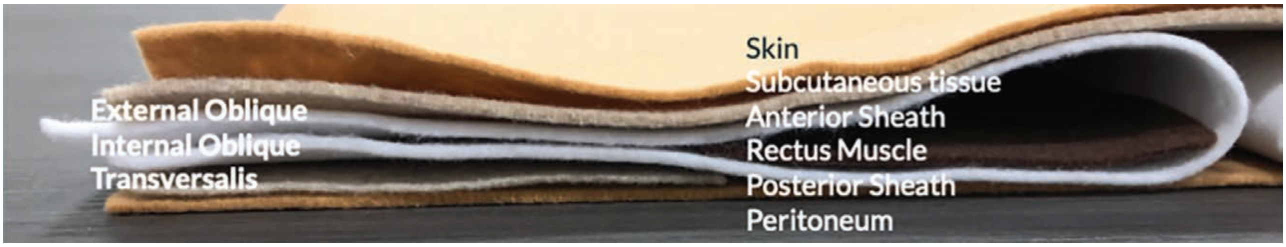

Fig. 2. Magnified view of one side of the abdominal wall model.

Fig. 3. Posterior component separation to develop the retrorectus plane.

Fig. 4. Placement of a square plastic sheet simulating a mesh in the retrorectus space after the midline posterior sheath was approximated.

Video 1 demonstrates how the model can be used for a retrorectus hernia repair with incision of the posterior rectus sheath (**See Video 1 [online],** which displays incising the posterior rectus sheath for development of the retrorectus plane.) and separation of components (Fig. 3). After this is completed on both sides, the posterior sheath is approximated with suture, and then a plastic square is placed to represent the placement of mesh in the retrorectus space (Fig. 4). For the sake of brevity, we will not demonstrate each hernia repair and muscle release, but Video 2 does demonstrate an example of how the model can be used to demonstrate a transversus abdominis release. (**See Video 2 [online],** which displays the transversus abdominus release.) This model can be used to demonstrate many other surgical maneuvers to understand anatomic relationships and simply to rehearse the steps of different operations.

The utilization of this model has assisted residents and medical students in their understanding of abdominal wall anatomy and the utilization of the components of the abdominal wall that are necessary for the most common types of abdominal access and abdominal wall reconstruction surgeries. This model has limitations as it is made of felt squares of uniform thickness and does not provide actual properties of human tissue and will not help assist in better tissue handling or aid in the ability to differentiate each layer based upon their intrinsic characteristics. With an understanding of the limitations of this model, utilizing an inexpensive, easily accessible abdominal wall model can help improve surgical education. Further investigation is needed to assess the efficacy of this model.

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