An inexpensive inguinal hernia teaching model

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Medical students find the complex anatomy of the inguinal region and thus the logic and steps of inguinal hernia operations difficult to understand. Cadaveric dissection or scrubbing in on an inguinal hernia operation are arguably the best ways of learning surgical anatomy. Unfortunately, cadaveric dissection at the undergraduate level is becoming less common[1] and medical students may not always be allowed to scrub in on an operation.

Many teaching models[2,3] have been developed to aid the learning of applied inguinal anatomy. These have limitations, including lack of anatomical realism, cost and availability. This letter describes the construction and use of a model of the inguinal region to depict anatomy in a quasi-3-dimensional style. It uses cheap, easily procured materials.

Construction of the model

Materials:

1. *Faux leather sections in different colours.* These were procured from cut pieces discarded by an upholsterer.

2. *Plastic tubing.* Bits of heat-shrink tubing were used.

3. *Cling film*

4. *A piece of nylon netting as for example from a garlic net-bag*

5. *Yellow-coloured tissue paper*

6. *A piece of stiff, white cardboard* about 25 x 25 cm

7. *Glue and double-sided sticky tape*

Construction (Figures I and II):

The model depicted a life-size hemi-pelvis and the musculo-aponeurotic layers of the abdominal wall from the level of the arcuate line down to the inguinal ligament. A standard undergraduate anatomy text[4] was used as a guide. The model was assembled as follows:

1. A hemi-pelvis was sketched on a piece of white cardboard.

2. The femoral vessels were drawn as guides to the position of the mid-inguinal point and the internal ring (deep inguinal ring) (IR).

3. The proximal course of the inferior epigastric artery (IEA), from its origin to the medial border of the rectus abdominis muscle (RA), was simulated with a piece of tubing and glued into its anatomical position on the cardboard drawing.

4. Using the drawing as a guide, appropriately sized faux-leather pieces of different colours were cut to represent the transversalis fascia (TF), transversus abdominis (TA), internal oblique (IO), rectus abdominis (RA) and the external oblique aponeurosis (EO). Since the model extended only up to the arcuate line, the TA and IO and EO were all disposed to pass anterior to the RA muscle.

5. These layers were then placed in position and trimmed where required.

   a. The TF was placed first. Inferiorly, it was allowed to overlap the femoral vessels to show how it constitutes the anterior layer of the femoral sheath (FS).

   b. The tubing representing the IEA could be felt through the TF and was depicted on the TF by colouring the corresponding area pink.

   c. A small hole was cut out in the TF just lateral to the IEA to correspond to the IR.

6. After all the layers were in place, an oblique, V-shaped section was removed from the EO to simulate the external ring (superficial inguinal ring, ER).

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7. The EO was then cut from the ER obliquely up to the mid-inguinal point to simulate a surgical incision.

8. A detachable, indirect hernia sac (IH) with contained omentum was constructed from a bit of cling film and yellow tissue paper and placed in the inguinal canal, its "neck" shown to be emerging through the IR.

9. A piece of tubing representing the spermatic cord (SC) was placed medial to the sac while emerging from the IR and was distally positioned to pass through the ER.

10. Once all adjustments were made, the layers were glued onto the cardboard sheet laterally and medially using the drawing as a guide.

11. The EO was folded upon itself inferiorly from the anterior superior iliac spine to the pubic tubercle to simulate the inguinal ligament (IL).

Figure I: The model with the external oblique and its aponeurosis (EO). The aponeurosis has been slit from the external ring (ER) to the mid-inguinal point to show the spermatic cord (SC) and an indirect inguinal hernia sac (IH) in the inguinal canal. The transversalis fascia is shown continuing inferiorly as the anterior layer of the femoral sheath (FS)
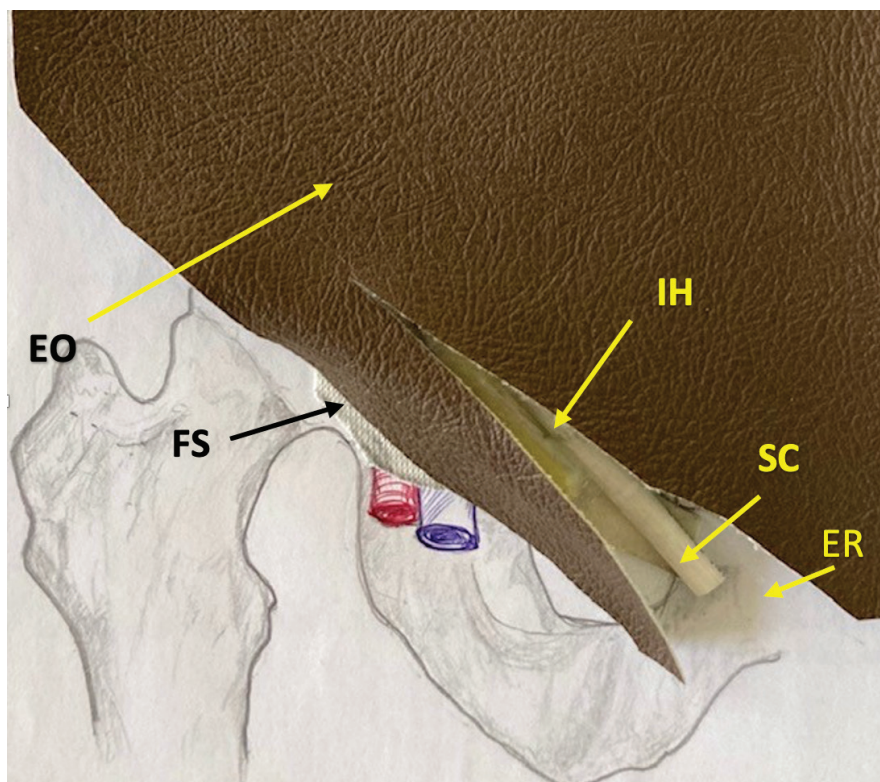
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Figure II: Inguinal canal detail. Upon retracting the upper and lower external oblique (EO) aponeurotic flaps, the internal oblique (IO, inguinal ligament (IL), transversalis fascia (TF), internal ring (IR), spermatic cord (SC) and hernial sac with contained omentum (IH) are seen.

Retracting the IO reveals the transversus abdominis (TA). The rectus abdominis (RA, digitally colour-enhanced for clarity) is shown in the model only to aid understanding (it is not seen in the course of an open inguinal hernioplasty). The inferior epigastric artery (IEA) lies medial to the exit of the spermatic cord and hernial sac through the internal ring. The TF continues into the upper thigh as the anterior layer of the femoral sheath (FS).
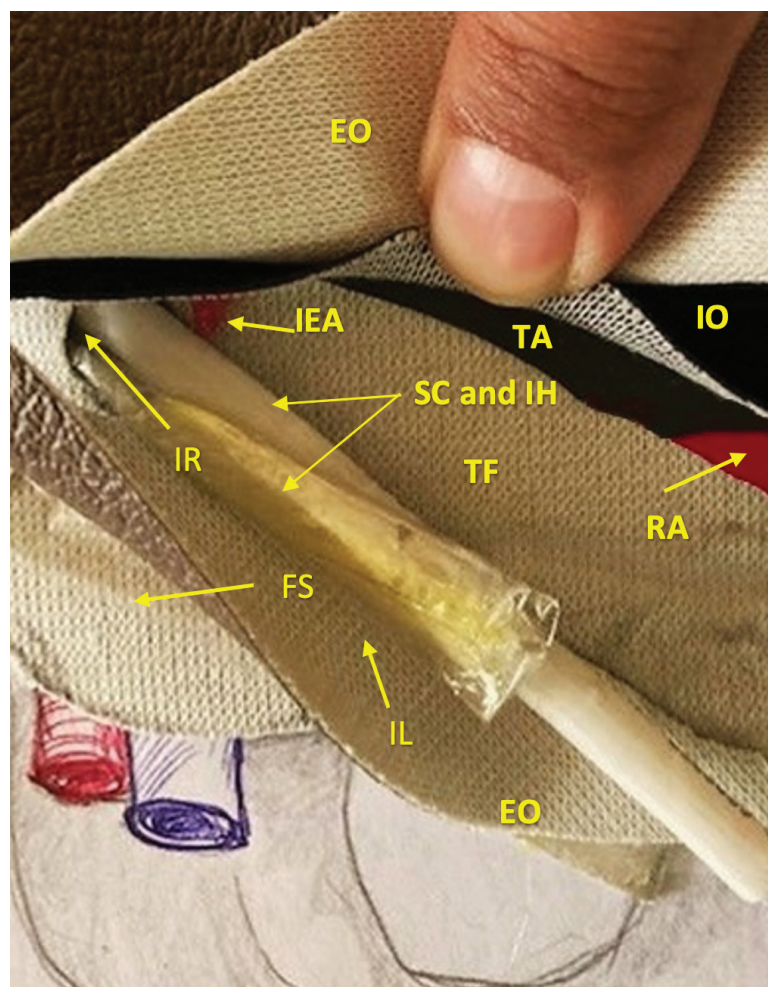
The faux-leather material used for the fascio-aponeurotic layers was soft enough to allow handling. The edges of the "incision" made in the EO were capable of being retracted to reveal the inguinal canal and its contents. The arching IO could be seen and, when this was retracted, the TA was visible. While the RA was hidden from view, the TA and IO could be elevated to reveal the RA and demonstrate that the TA and IO pass anterior to the RA at this level.

The model is nearly flat, smaller than an A4 size paper sheet and compact enough to be carried in a C4 size envelope.
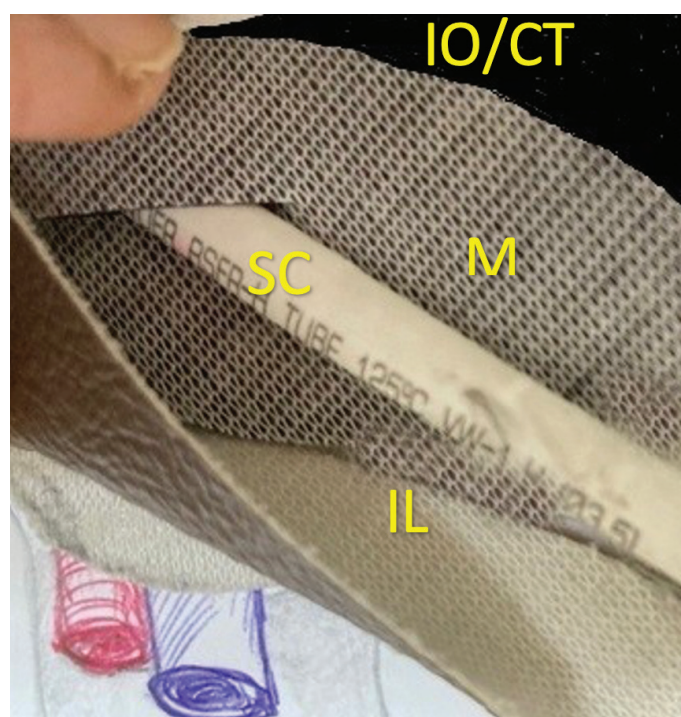
Using the model

The student locates the mid-inguinal point using the femoral artery as a guide. The external ring is located and the inguinal incision is made. By retracting the EO flaps, the inguinal canal, its contents (sac and cord) are revealed. The formation of the inguinal ligament by the folded inferior free edge of the EO is demonstrated.

Particular attention is paid to the TF and location of the IEA, the internal ring and the relationship of the sac to the cord. Next, the IO and TA are demonstrated, mentioning how, in a significant percentage of the population, these are fused medially to form the conjoined tendon. The indirect hernia sac emerging from the internal ring and its relationship to the cord may be appreciated at this stage. Although this model shows only an indirect hernia, it is easy to demonstrate the location of a direct hernia in Hesselbach's triangle using the IEA as a guide.

The essential steps of a Lichtenstein procedure[5] for an inguinal hernia are then demonstrated. In the model, the sac can be detached to simulate a herniotomy. The rationale for imbrication of the TF in the repair of a *direct* hernia is explained. The placement of a mesh is then shown (Figure III), as is its anchoring to the TA/conjoined tendon superiorly and the inguinal ligament inferiorly. The relationship of the SC to the mesh is also shown.

Figure III: Mesh placement in a Lichtenstein repair. The mesh (M) is fixed in position, fixed to the internal oblique/conjoined tendon (IO/CT) superiorly and the inguinal ligament (IL) inferiorly, and slit laterally to accommodate the cord (SC)

Discussion

The purpose of this simple model is not to teach the technical details of inguinal hernia repair to a trainee surgeon for which a more appropriate model[3] is available but to assist medical students in understanding the anatomy of the inguinal region and the basic steps of a popular technique[5] of inguinal hernioplasty. To that end, the model was kept simple and many details, such as the three nerves encountered in the inguinal canal at surgery, were omitted. Likewise, the pectinate ligament (Cooper's ligament) has not been shown, rendering the model inadequate to explain procedures that use this structure. These are deficiencies that can be easily incorporated in improved models without over-compromising simplicity.

The model has been, and continues to be, used for teaching senior medical students. It received an enthusiastic response and informal feedback has been very positive, clearly suggesting that it now deserves to be objectively evaluated as a teaching aid.

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