

6 - Cadaver as an experimental model to study abdominal wall tension¹

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ABSTRACT - The use of cadaver as an experimental model to evaluate tension of the abdominal wall after aponeurotic incisions and muscular undermining is described on this article. The tension required to pull the anterior and the posterior rectus sheaths towards the midline was studied in fresh cadavers at two levels: 3 cm above and 2 cm below the umbilicus. Traction measurement was assessed with a dynamometer attached to suture loops on the anterior and posterior recti sheaths, close to the midline, above and below the umbilicus. The quotient of the force used to mobilize the aponeurotic site to the midline and its resulting displacement was called the traction index. These indices were compared in three situations: 1) prior to any aponeurotic undermining; 2) after the incision of the anterior rectus sheath and the undermining of the rectus muscle from its posterior sheath; and 3) after additionally releasing and undermining of the external oblique muscle. The experimental model described showed to be feasible to demonstrate the effects on tension of the abdominal wall after incisions and undermining of its muscles and aponeurosis.

KEY WORDS - Cadaver. Incisional hernia. Rectus abdominis muscle. External oblique muscle. Components separation.

Introduction

The integrity of the abdominal wall must be maintained after reconstructive surgery.^{1,2,3,4} A technique that decreases the tension at the edges of the defect will decrease the rate of incisional hernias following TRAM flaps, tumor resection and closure of abdominal defects.⁵ Mesh has been widely used for reconstruction of these defects, decreasing tension is achieved by placing mesh between the edges of the defect.^{6,7} Since low tension at closure reduces aponeurotic dehiscence, there has been a movement toward inserting synthetic mesh in the past few years. However, the use of synthetic material may cause complications such as local chronic infection, mesh extrusion, bowel perforation and formation of fistulae.

Good abdominal wall support and maintenance of contractility are important goals of abdominal wall reconstruction.^{8,9} Contractility however, is not obtained with the use of mesh. Also, the use of adjoining tissues during reconstruction will avoid the complications previously described.

Do allow medial mobilization of the abdominal wall with lower resistance at closure?

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Proposition

The purpose of this study is to report and bring to light the use of cadaver as an experimental model to evaluate tension of the abdominal wall after aponeurotic incisions and muscular undermining.

Method description

Anatomic Study

Fresh adult cadavers were dissected at room temperature (22° C.) and studied from December 1994 to April 1996. None had had abdominal wall incisions or hernias. Ages ranged from 34 to 82 years, the median being 53.5 years. Cadavers from both genders were studied.

The cadaver was placed in supine position. An incision from the xyphoid process to the pubis exposed the linea alba. The fat was dissected from the aponeurosis by sharp dissection, as in the abdominoplasty procedure. The two levels to be studied were marked at three centimeters above (superior level) and two centimeters below (inferior level) the umbilicus (Figure 1 and 2).



FIGURE 1 Area of rectus diastasis is marked as well as the superior and inferior levels - 3 cm above and 2 cm below the umbilicus.

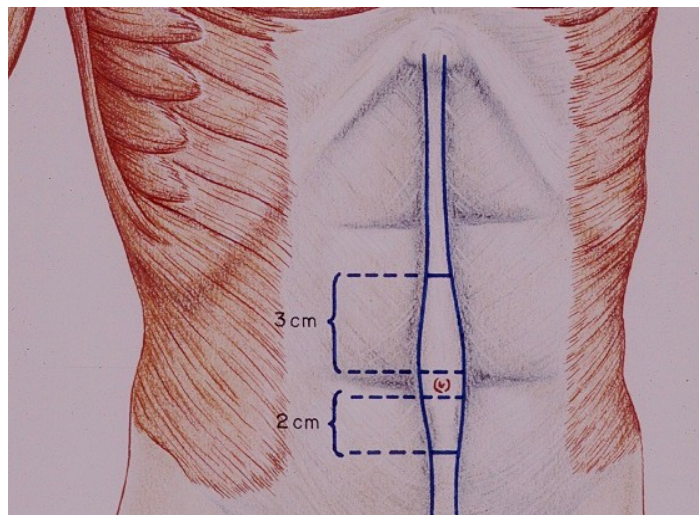


FIGURE 2 Scheme demonstrating the linea Alba and the superior and inferior levels.

Four aponeurotic sites were studied at each level on the medial edge of the rectus muscles, next to the linea alba, two at the anterior and two at the posterior aponeurosis. The following letters were used as anatomical references to describe these sites:

- s = supra-umbilical
- I = infra-umbilical
- a = anterior rectus sheath
- p = posterior rectus sheath
- l = left
- r = right

The four sites located at the supra-umbilical level were named: **rsa** (right superior-anterior), **lsa** (left inferior-anterior), **rsp** (right superior-posterior) and **lsp** (left superior-posterior). Following this pattern, the sites located at the infra-umbilical area were designated: **ria**, **lia**, **rip** and **lip** (Figure 3). The symmetric sites are equally distant to the midline. At each site, a loop was made with a 2-0 nylon suture.

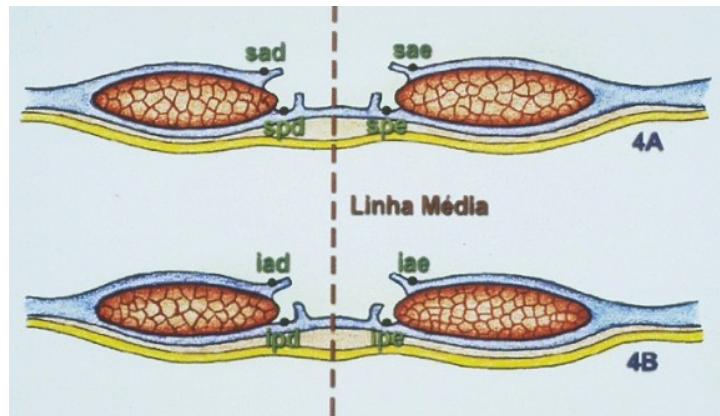


FIGURE 3 Scheme demonstrating the location of the aponeurotic sites: A - Supra-umbilical level sites **rsa**, **lsa**, **rsp** e **lsp**; B - Infra-umbilical level sites **ria**, **lia**, **rip** e **lip**.

In order to measure the necessary traction to mobilize each aponeurotic site to the midline, a dynamometer (Crown Dynamometer; Filizola Industry, São Paulo, Brazil) hooked to the loop was used (Figure 4).



FIGURE 4 Dynamometer used to measure traction of the abdominal wall.

The midline served as a reference for all measurements performed. A suture was used to mark the midline. Traction was measured by placing the dynamometer perpendicular to the suture and parallel to the aponeurosis (Figure 5). Each measurement was repeated by a second observer. In the case of discrepancy, a third observer would make a measurement, and the two in closest agreement were selected for.

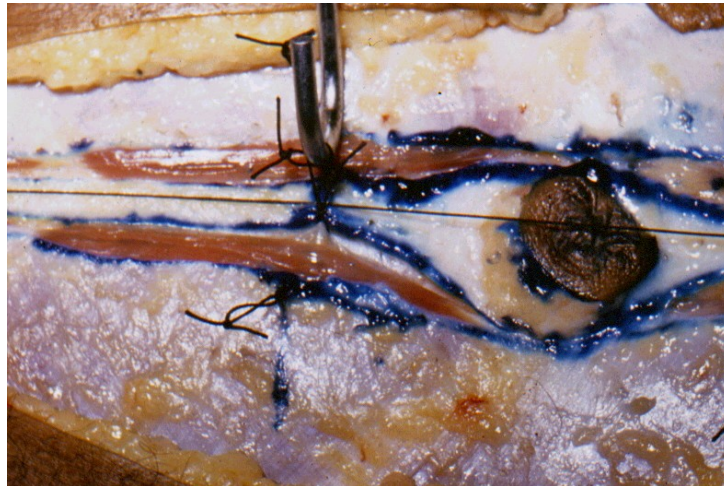


FIGURE 5 Traction measurement on the right superior posterior site (**rsp**). Note the dynamometer's hook, positioned perpendicularly to the midline. The traction was measured tangentially to the aponeurosis

Traction was measured on aponeurotic sites described, during three stages of dissection:

- A) Initial stage, before any aponeurotic undermining;
- B) Stage 1, after the first dissection in which the rectus abdominis muscle is dissected from its posterior rectus sheath;
- C) Stage 2, after the second dissection. Incision and undermining of the external oblique aponeurosis is performed in addition to the maneuver in stage 1.

The sequence of anatomic dissection will be described as follows:

Traction measurement of initial stage

After aponeurotic exposure, traction was measured at sites **rsa**, **lsa**, **ria** and **lia**. Two longitudinal incisions were made on the anterior rectus sheath, next to the linea alba, from 2 cm below the xyphoid process to the arcuate line. These incisions were made to approach the posterior rectus sheath. At this point no dissection was performed. Traction was measured again at the same sites of the anterior rectus sheath. Therefore, two values of traction were obtained at each site of the anterior rectus sheath at the initial stage.

Four sutures with loops, **rsp**, **lsp**, **rip** and **lip**, were placed in the posterior rectus sheath. They were placed at the same level as those at the anterior rectus sheath. Traction to the midline of these sites was also measured (Figure 6).

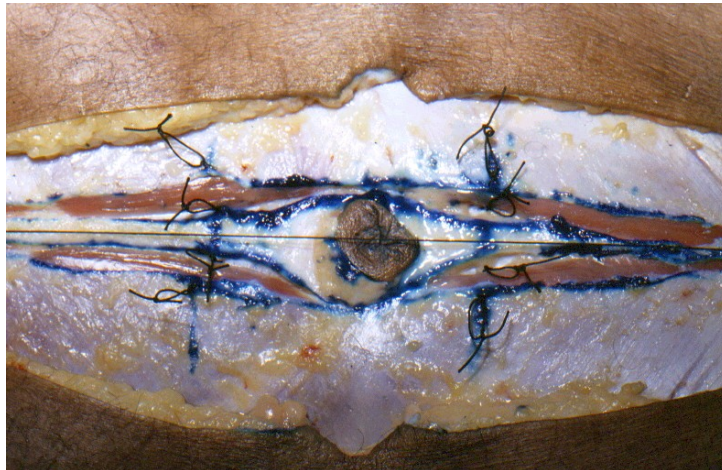


FIGURE 6 Suture loops on the supra and infra umbilical sites, on the anterior and posterior rectus sheath.

Traction measurement of stage 1

The rectus muscles were completely dissected from their posterior sheaths. However, they were kept attached to the anterior aponeurosis. At this point, traction of the eight sites was measured (Figure 7).

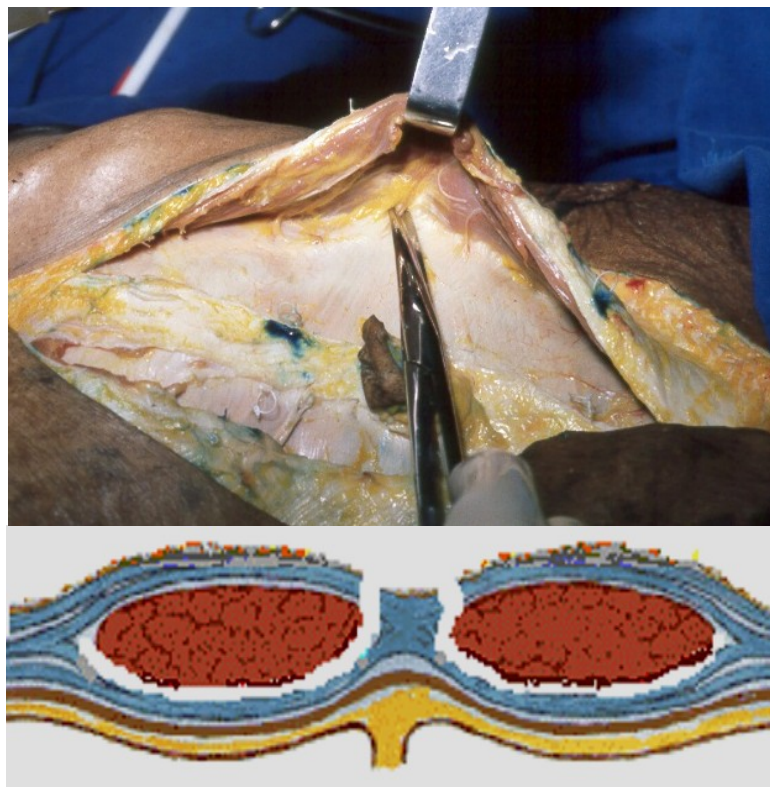


FIGURE 7 - Stage 1 Rectus abdominis muscle undermined from its posterior sheath.

Traction measurement of stage 2

Incisions were made at the semilunar line, dividing the aponeurosis of the external oblique from the costal margin to the reflected inguinal ligament. These muscles were undermined laterally to the anterior axillary line where the vascular pedicle penetrates the muscle; superiorly to the costal margin; and inferiorly to the inguinal ligament (Figure 8). Traction was again measured at the eight sites.

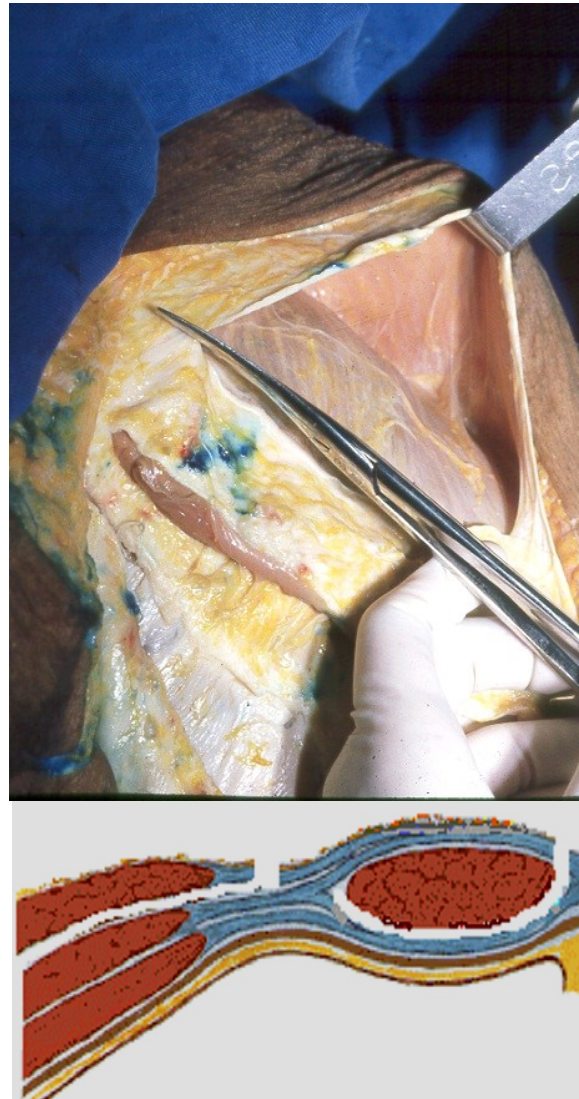


FIGURE 8 - Stage 2 –Incision of the external oblique aponeurosis along the semilunar line and undermining of the muscle laterally to the anterior axillary line.

Traction index

Traction obtained at each site was related to the distance between these sites and the midline. This relation was called traction index:

$$TI = \frac{F}{d}$$

Where TI = Traction index (Kg/cm); F = traction force at the site (Kg); d = distance from the aponeurotic site to the midline (cm).

In order to obtain a more accurate analysis, the average of the traction index between the two symmetric sites (left and right) was used. This average was represented by the letters of the aponeurotic sites. The mean traction index **SA** (supero-anterior) was obtained between the traction indexes of both sites: **lsa** (left supero-anterior) and **rsa** (right supero-anterior). The other mean traction indices at the initial stage were: **SP** (supero-posterior), **IA** (inferior-anterior), and **IP** (inferior-posterior) (Figure 9). After the first dissection, the mean traction indices were designated **SA1**, **SP1**, **IA1**, **IP1**, and after the second dissection, **SA2**, **SP2**, **IA2**, **IP2**.

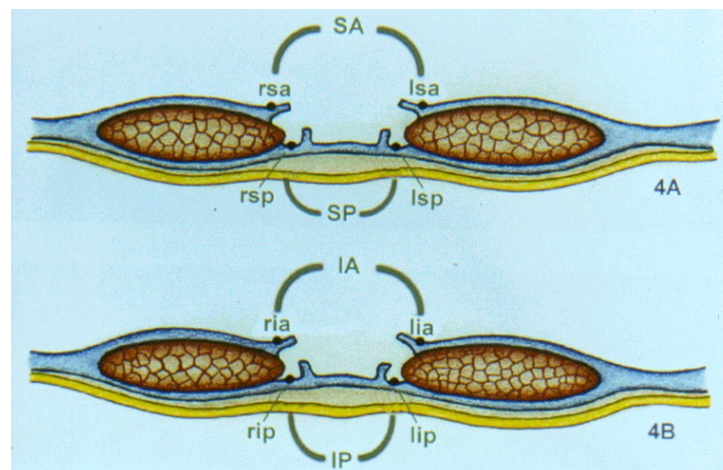


FIGURE 9 Scheme showing the location of the aponeurotic sites and the traction indices: **A** Supra-umbilical sites: **rsa**, **lsa**, **rsp**, **lsp**, and the traction indices **SA** and **SP**; **B** Infra-umbilical sites **ria**, **lia**, **rip**, **lip**, and the traction indices **IA** e **IP**.

Perspectives

The experimental model described showed to be feasible to demonstrate the effects on tension of the abdominal wall after incisions and undermining of its muscles and aponeurosis. This model may be used on the evaluation of any technique used for abdominal wall reconstruction on which local flaps are used.

References

1. Nahas FX, Ferreira MC. Cirurgia reconstrutora da parede abdominal. In: Moraes IN, Melo JB, Nahas P. Residente de Cirurgia. São Paulo, Ed. Roca, 1992, p.469-74.
2. Nahas FX. Reconstrução da parede abdominal por via laparoscópica. Arq Bras Cir Digest 1993;8:132-3.
3. Nahas FX. Studies on the endoscopic correction of diastasis recti. Oper Tech Plast Reconstr Surg 1996;3: 58-61.
4. Nahas FX, Augusto SM, Ghelfond C. Should diastasis recti be corrected? Aesthetic Plast Surg 1997;21(4):285-9.
5. Dibello Jr JN, Moore Jr JH. Sliding myofascial flap of rectus abdominus muscle for the closure of recurrent ventral hernias. Plast Reconstr Surg 1996;98:464-9.
6. Bendavid R. The rational use of mesh in hernias. A perspective. Int. Surg., 1992, v.77, p.229-31.
7. Liakakos T, Karanikas I, Panagiotidis H, Dendrinis S. Use of Marlex mesh in the repair of recurrent incisional hernia. Br J Surg. 1994;81(2):248-9.
8. Nahas FX. Resistência músculo-aponeurótica da parede abdominal à tração medial após secção e descolamento aponeurótico seletivo [Tese de Doutorado] São Paulo: Faculdade de Medicina da Universidade de São Paulo;1997.
9. Nahas FX, Ishida J, Gemperli R, Ferreira MC. Abdominal wall closure after selective aponeurotic incision and undermining. Ann Plast Surg 1998;41(6):606.

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RESUMO - O uso de cadáver como modelo experimental para a avaliação da tensão da parede abdominal após incisões aponeuróticas e descolamentos musculares é descrito neste artigo. A tensão necessária para levar a aponeurose anterior e posterior do músculo reto até a linha média foi estudada em cadáveres frescos em dois níveis: 3 cm superior e 2 cm inferiormente à cicatriz umbilical. As medidas de tração foram realizadas com o uso de um dinamômetro acoplado às alças realizadas com fio de sutura na aponeurose anterior e posterior dos retos, próximas à linha média, nos níveis supra e infra-umbilicais. A tração utilizada para mobilizar os pontos aponeuróticos até a linha média e seu deslocamento resultante foram denominados coeficiente de tração. Estes índices foram comparados em três situações: 1) anteriormente a qualquer descolamento; 2) após a incisão da aponeurose anterior do reto e o descolamento do músculo reto de sua aponeurose posterior; e 3) após, além da manobra anterior, a liberação e descolamento do músculo oblíquo externo. O modelo experimental descrito mostrou-se factível na avaliação da alteração da tensão na parede abdominal após incisões e descolamentos destes músculos e aponeuroses.

DESCRITORES - Cadáver. Hérnia incisional. Músculo reto abdominal. Músculo oblíquo externo. Separação de componentes.

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