Surgical Physiopathology of the Inguinal Region

The myriad of procedures for the treatment of hernias raises the suspicion that some unknown element conditions the not always perfect outcome of surgery; indeed, were an effective therapy available, the continued attempts to modify and improve existing procedures wouldn't be necessary. This observation underpins the reflections on the topic that follow.

If we recall the main approach used for decades and still adopted in many settings for certain indications, that is the Bassini technique, we note that the characteristic feature of the operation is the incision of the *transversalis fascia* (TF), execution of the triple layer and its attachment to the inguinal and Colle's ligaments.

Attilio Catterina, Bassini's pupil and long-time deputy and Full Professor of surgery at the University of Genoa, spread his teacher's technique, and the illustrations contained in his work of 1932 are, beyond being a historical document, an important source of information about the principle on which Bassini's procedure is founded: the importance of the transversalis fascia.

Fig.1 – The transversalis fascia

Fig. 2 – Incision of transversalis fascia: the epigastric vessels

Fig. 3 – The triple layer

For many years this operation constituted the therapy of choice, not only in Italian centers. In my experience, in the footsteps of my teachers, it was the gold standard for hundreds of operated patients.

There was a time, however, when the incision of the TF was deemed not only superfluous, but even detrimental. Indeed, it was thought that the opening might represent a weakness in the reconstruction of the wall, and not without reason, considering that preperitoneal fat is extruded outward, thus reproducing the picture of the direct hernia. As a result, for some time rather than executing a triple layer a double layer was created: the internal oblique and transversus muscle with the TF. The (also early) relapse rate experienced with this technique literally soared, however, and lead to return of the triple layer procedure.

I wanted to highlight the above to underline Bassini's intuition, obviously fruit of a profound knowledge of not only anatomy, but likewise of the normal and pathological mechanisms of the structure, that is, of the *physiopathology of the inguinal region*.

Physiopathology is seldom used to identify the normal and pathological functions of a muscular-aponeurotic structures like the one found in the region discussed here. Nevertheless, I am of the opinion that the term aptly conveys the complex of mechanisms which regulate the structures of

the region and which, moreover, are related to even distant muscular-aponeurotic regions, as we will see, and obviously to splanchnic and visceral structures.
To talk about function we need to understand the anatomy: following Robert Condon's advice, if in the middle of the inguinal region a needle is introduced from the skin all the way to the abdominal cavity, two distinct complexes of structures are met: these represent two groups distributed evenly on either side of the spermatic cord.
Indeed,

from outside:
Skin - subcutaneous fat - innominate fascia - external oblique aponeurosis
from within:
Peritoneum - preperitoneal fat - transversalis fascia - aponeurosis (transversus + internal oblique)

I purposefully underlined these shared elements of the two layers, precisely to emphasize the identical succession from a covering (skin, peritoneum) to an aponeurosis. The outer group serves to cover, while the inner group contains.
From a surgical standpoint, a preliminary consideration is due at this point: if the group that covers is weak, a prosthesis applied to the aponeurotic layer of the containment group (see Lichtenstein's repair and similar procedures) will not provide sufficient coverage. The containing action is thus performed by the second group, whose constituent elements play to a varying degree - be it for anatomic structure or for functional properties - a decisive role in the physiopathology of the region. Because the containing action must offset weight and endo-abdominal pressure, we'll first examine the region from the inside out.
It must first be said that abdominal pressure can reach high levels, both for the weight of the endo-abdominal contents and for specific moments of stress (a cough, for example), and that in the region in question the muscular-aponeurotic wall presents an aperture that represents a hiatus in the abdominal wall through which herniation would regularly occur were it not for the apparatuses that hold it in check.

Many Authors have redefined the containing importance of the TF, thereby evoking the principle underlying the Bassini technique. Ernest Lampe recalls that the TF is a sheath that surrounds the abdominal cavity like a sack, a concept shared by many other Authors.
Indeed, this membrane establishes relevant connections with muscular-aponeurotic and bone structures while delimiting and enveloping the *entire* abdominal cavity (Fig. 4): from above it is fused with the diaphragmatic fascia, blending with the last ribs, the first lumbar vertebrae and the lumbodorsal fascia; below and laterally, it unites with the fascia of the psoas and the Quadratus lumborum; anteriorly, it runs along the Recti abdominis, while above it lines the aponeurosis of the

transversus muscle, about one-fourth to one-fifth down the Recti, with which it is in direct contact (Fig 5). As is known, *Douglas' semicircular arch* marks the passage.

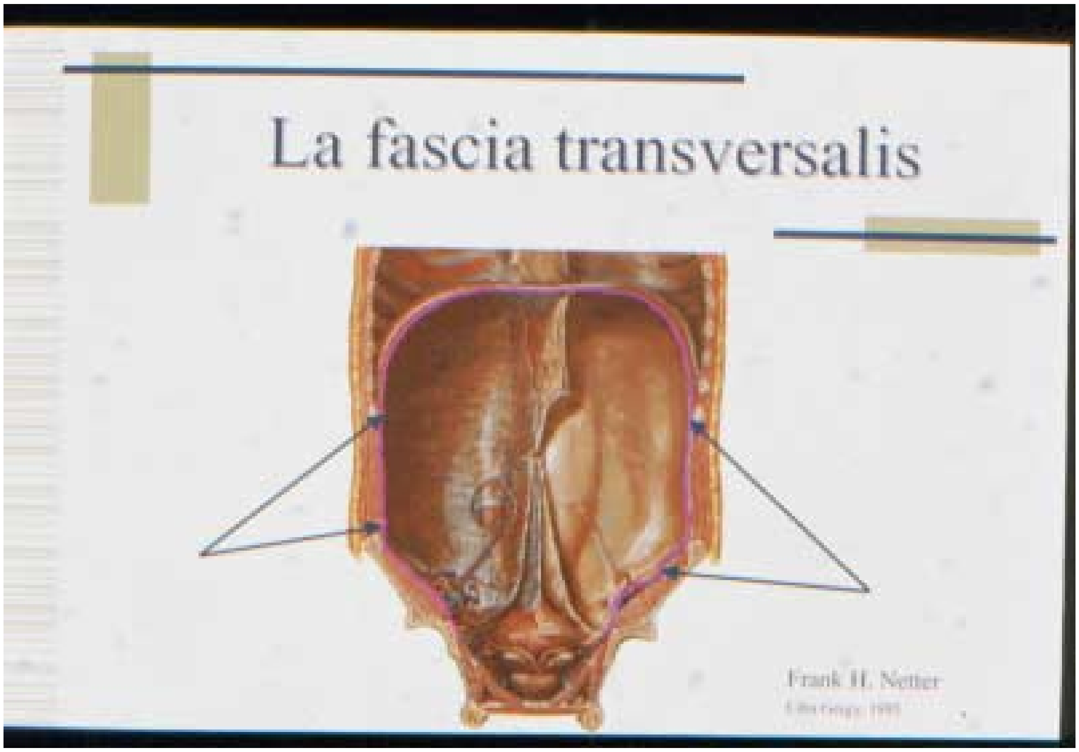

Fig. 4

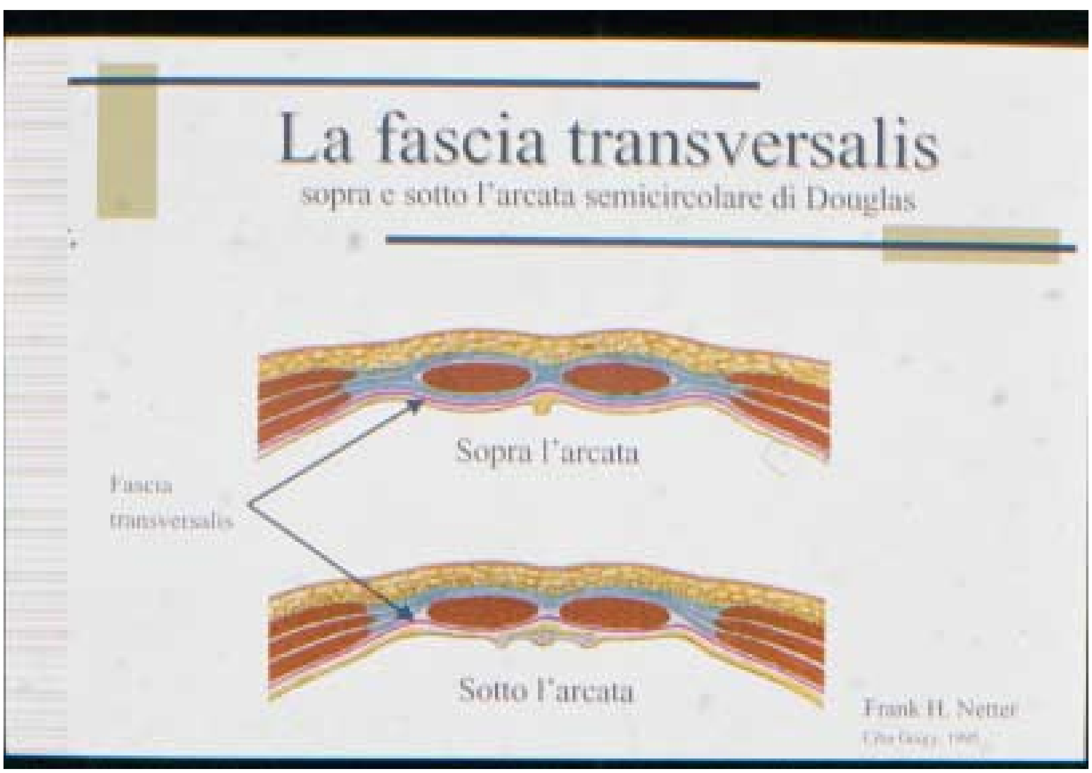

Fig. 5

Overlooking the details of other connections this structure has, it is enough to reflect on the image conveyed above, i.e., that of a sac (Fig. 6), hanging from the muscular-aponeurotic and bone structures of the upper abdomen and stretched taught by posterior and lateral connections and it becomes clear that the state of tension is influenced by the action of the muscular-aponeurotic structure and particularly the activity of the diaphragm and the thoracic cage.

Fig. 6

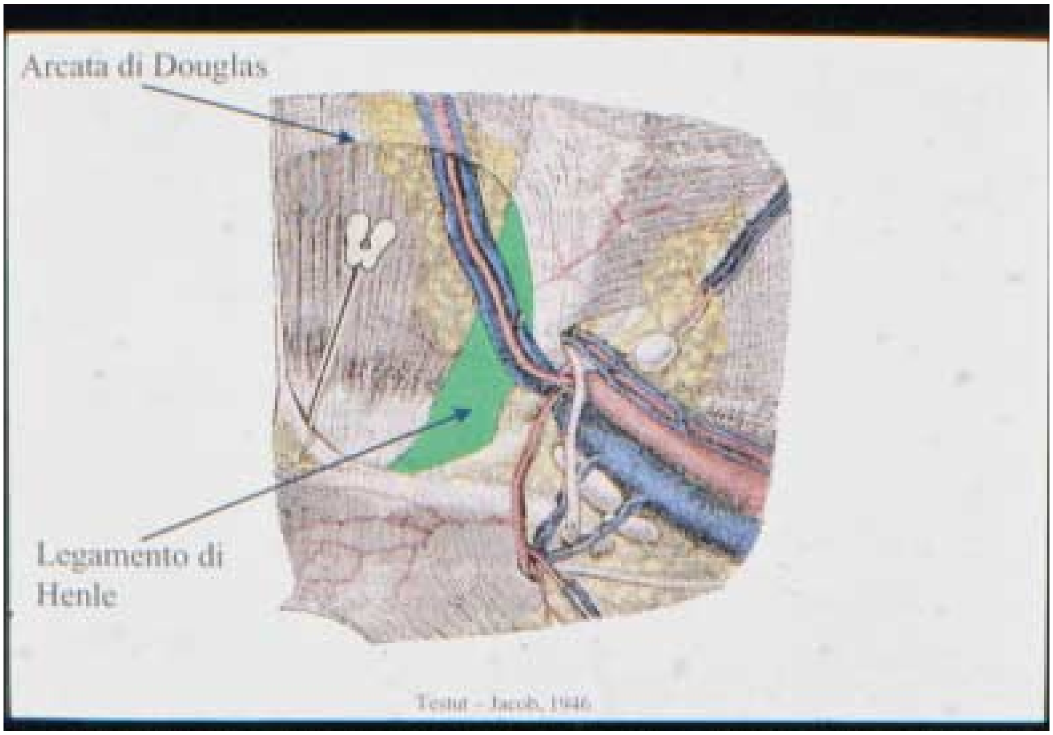

Fig. 7

Moving downwards to the region in question we can start from the semicircular line of Douglas: at this point the TF thickens medially to form *Henle's ligament* (Fig. 7), which lying immediately laterally to the Rectus, takes the shape of a base-down triangle. Its lateral margin is concave, falciform, for which His called it the *inguinal falx*. This structure adheres with its base to Cooper's ligament, another important connection of the TF. The anterior face of Henle's ligament corresponds to the *conjoint tendon* with which it is joined. This configuration has given rise to the definition of the entire complex of Henle's ligament plus the conjoint tendon with the term inguinal falx. This relationship is noteworthy because, as we will see, it represents one of the most important containment systems.

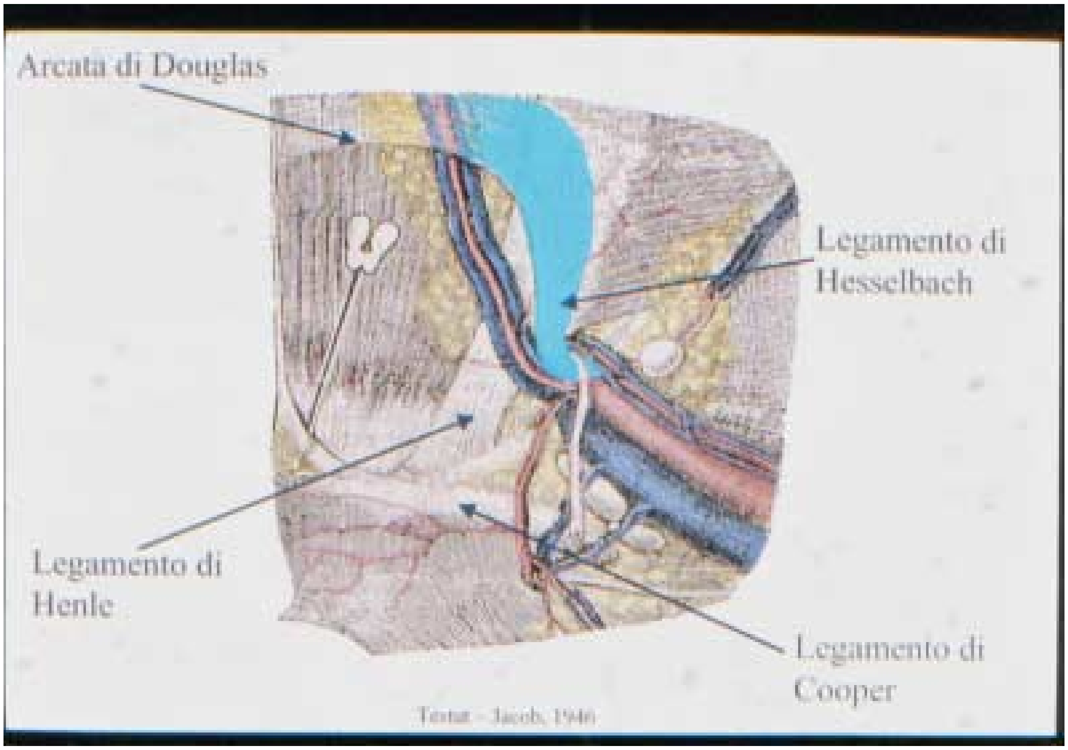

Fig. 8

Laterally, the semicircular line of Douglas thickens to form a pillar, namely the lateral arch pillar, which continues in *Hesselbach's interfoveolar ligament* (Fig. 8), referred to as such since it is wedged between the external abdominal ring and the medial fossa. This structure inserts downwards into the inguinal ligament after having surrounded the deep abdominal ring inferiorly. Its importance in containment at the level of this latter is therefore apparent.

Even further laterally we find an equally interesting structure (Fig. 9) formed by the TF that English speaking Authors have coined the *Transversalis fascial sling*. This structure arises from the TF's introduction into the deep abdominal ring like a cul-de-sac funnel that continues with the internal spermatic fascia. Nevertheless, this funnel is not perfectly conical, but is slanted, thus constituting a super-medial fold with respect to the ring where the reinforcement of the interfoveolar ligament also exists. This structure guarantees a closing mechanism for the ring when endo-abdominal pressure increases: indeed, when the transversus muscle contracts, e.g., during a cough, it stretches the funnel upwards, thus providing a closing (albeit partial) of the ring.

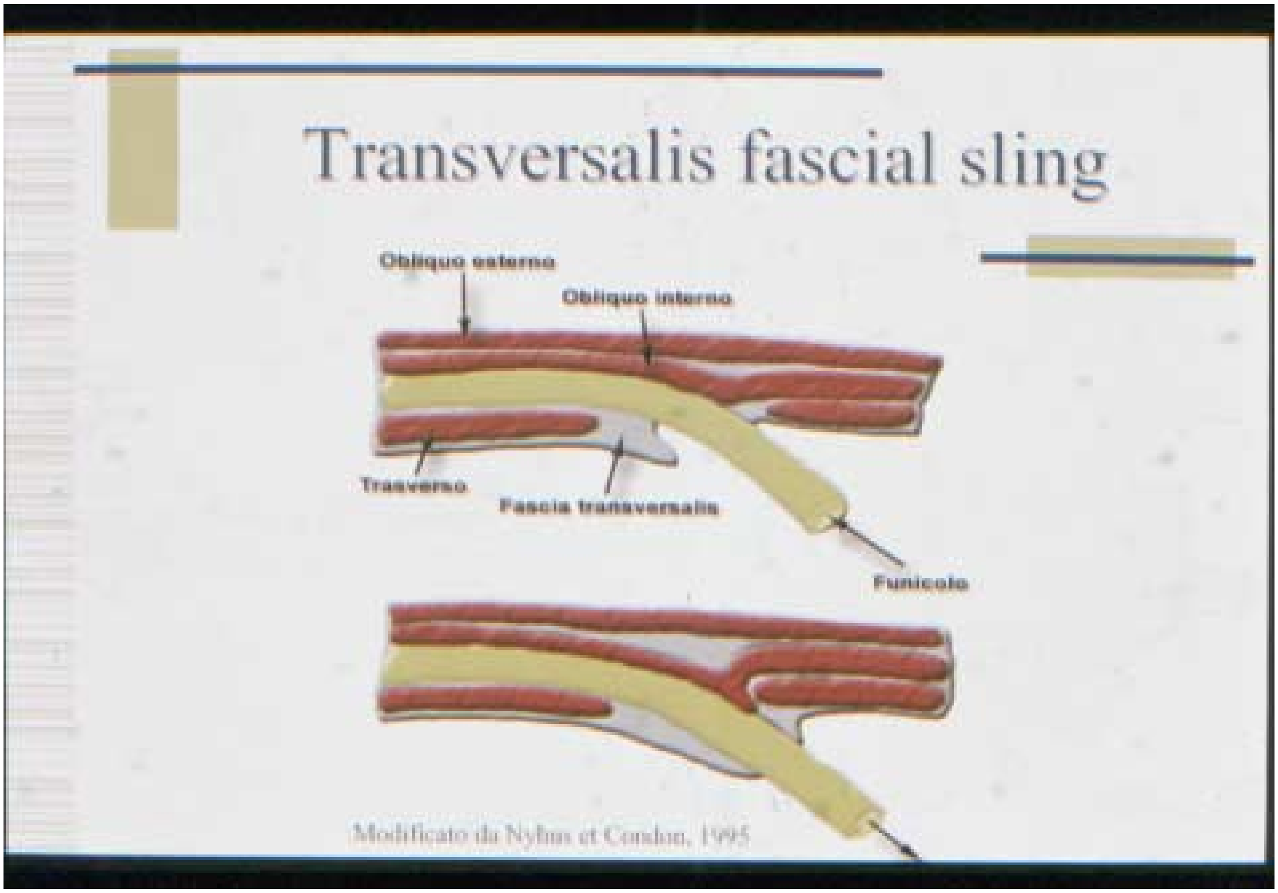

Fig. 9

Summarizing, the TF represents a valid containment structure thanks to

- its connections with muscular-aponeurotic and bone structures of the upper abdomen;
- Henle's ligament (and its adherence to Cooper's ligament);
- Hesselbach's interfoveolar ligament (fibers of the inferior margin of the deep abdominal ring)
- The "sling" (and connections with the transversus muscle and its valvular mechanism).

The presence - and hence structure, strength and resistance - of these constituent elements may vary; as a consequence, endo-abdominal pressure may in certain cases cause herniation at either the deep abdominal ring or the posterior wall of the canal.

Other structures exist (Fig 10) which, if well-formed, contribute to the containment action: these are the transversus and internal oblique muscles, the conjoint tendon and Colles' ligament. The internal oblique muscle arises in the region surrounding above the deep abdominal ring and proceeding with its free margin, thereby creating with the free margin of the transversus muscle the roof of the inguinal canal.

Fig. 10

The tissue of the two muscles may be more or less developed, but both soon continue with their aponeurosis, which together form the conjoint tendon. This then curves laterally to attach to the symphysis pubis, to the pubic tubercle and to Cooper's ligament. Posteriorly it adheres to Henle's ligament, with which it frequently fuses. For this reason the whole of these elements has earned the name inguinal falx. In front of the falx we find the transversal fibers of Colles' ligament, which originate from the aponeuroses of the contra-lateral external oblique muscle and intersect with the midline. This ligament is inserted to a varying extent into the anterior pubic margin, and particularly the tubercle, and may even reach the medial part of the pectineal crest.

The inguinal falx then forms the curved superior edge of the inguinal hiatus (Fig. 11), whose rectilinear base is given by Falloppio-Poupart's inguinal ligament. This, too, forms an important containment system, but its effectiveness depends on the tone of its constituents that restrict the hiatus to create a closure mechanism, almost a sphincteral apparatus in the eyes of some Authors, that reacts to an increase in endoabdominal pressure.

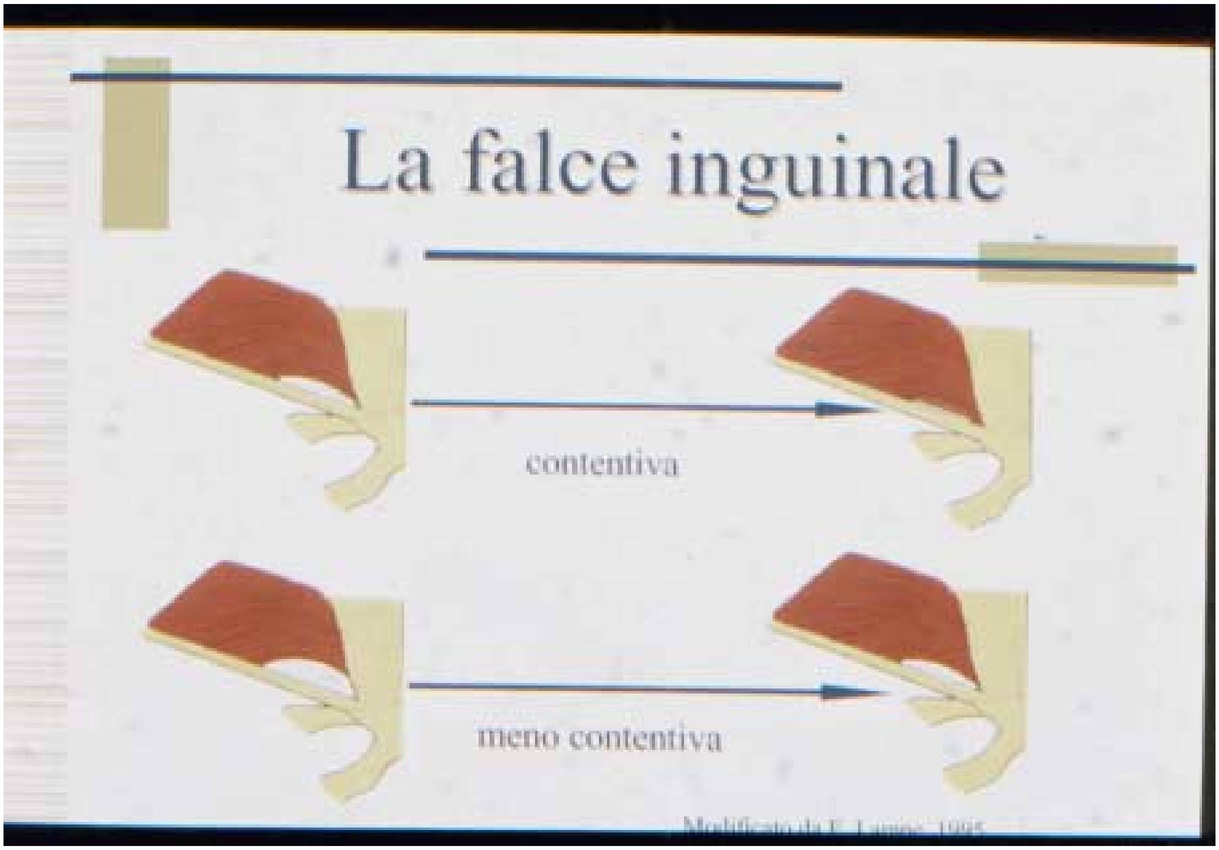
La falce inguinale
contentiva
meno contentiva

Fig. 11

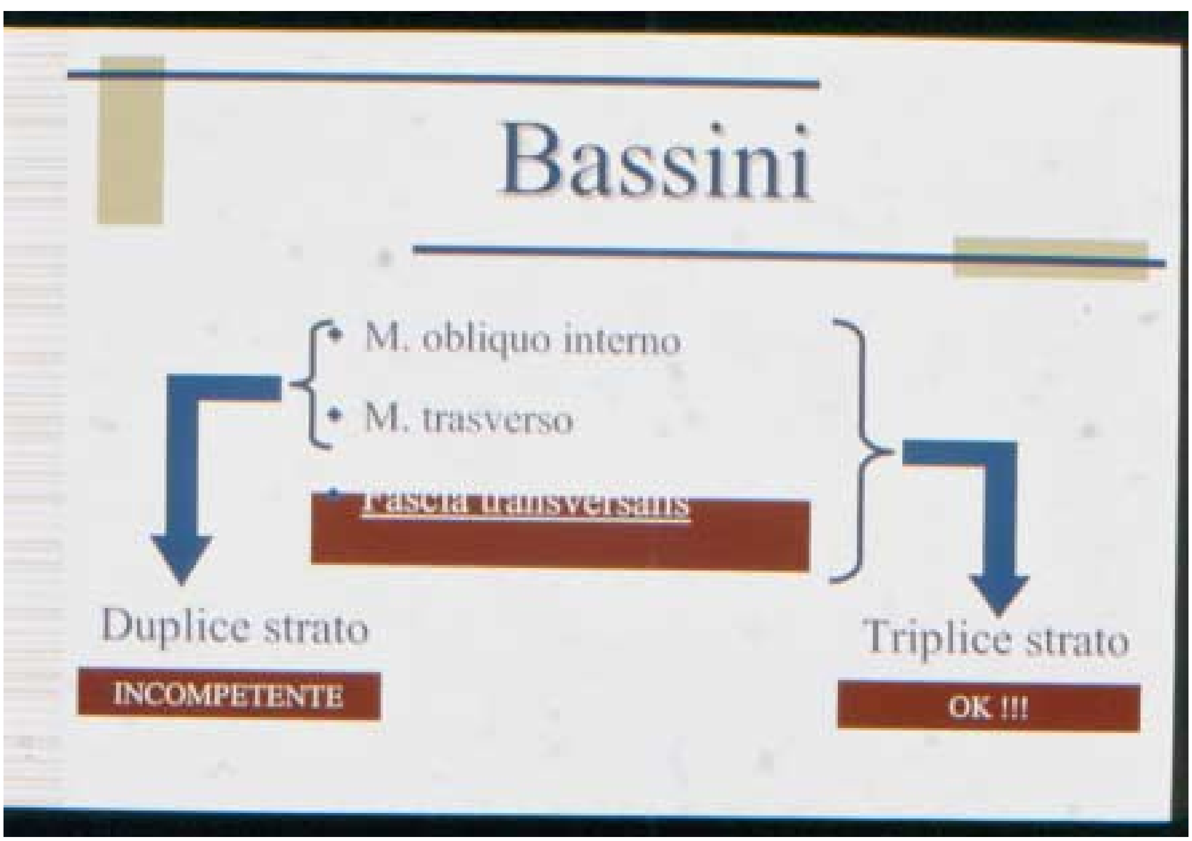
Bassini
M. obliquo interno
M. trasverso
Duplice strato
INCOMPETENTE
Triplice strato
OK !!!

Fig. 12

We thus have two containment systems for the inguinal hiatus: the TF and the inguinal falx. Under normal conditions they act synergistically to contain the wall; the relevance of each one's function, however, taken alone, becomes evident above all in the case of hernia repair.

Bassini's procedure, with the creation of a triple layer, can be likened to a mesh made up of the internal oblique and transversus muscles and conjoint tendon applied to reinforce the TF. As already mentioned, the ineffective containment experienced (Fig.12) when only the internal oblique and transversus muscles and their aponeuroses are used is proof that these two structures alone are not enough to serve the purpose. It likewise highlights the pivotal importance of the TF.

Procedures with mesh prostheses such as Lichtenstein's can no doubt be regarded as important advancements in hernia repair; nevertheless, these techniques do not entail intervention on the transversalis fascia, which remains unmodified. Clearly, if the membrane is weak and perforated, abdominal pressure bears on the prosthesis. Moreover, mesh that is not well-attached above all to Colle's ligament may lead to recurrence. Indeed, this is the most common defect seen by us in treating recurrent hernia after Lichtenstein's repair. In short, the containment mechanism of Lichtenstein's repair can be likened to a lid on a boiling pot that, if not placed snugly, runs the risk of blowing off.

The crucial role of the TF is proven by hernia repair procedures employing preperitoneal mesh prostheses. In fact, these procedures, performed with video-laparoscopic techniques or according to Stoppa's or Rives' methods, or still again with inguinal preperitoneal mesh (as in our series of long-term controlled cases showing positive results), repair involves only the TF. Moreover, positive outcomes have also been achieved with the above mentioned procedures, all of which (it is worth repeating) implicate only the TF. Above and beyond clinical results, these repair procedures confirm once and for all the predominance of the TF over other structures in assuring inguinal containment.

In conclusion, we can say that the inguinal region, the weak point of the abdominal wall due to the presence of the ring formed by the inguinal hiatus, is protected from endo-abdominal pressure by the combined action of numerous structures, the most important of which are the transversalis fascia and the inguinal falx. Of these two, the former plays the paramount role, confirming the gifted intuition of Edoardo Bassini.

For other data and references: Chirurgia Italiana 54,3, 2002