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ORIGINAL ARTICLE

“All-in-one mesh” hernioplasty: A new procedure for primary inguinal hernia open repair

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hernioplasty

Summary *Background:* We propose a new open mesh hernia repair procedure for the treatment of inguinal hernias in adults aiming to improve patients' comfort and to reduce the incidence of chronic neuralgia.

Methods: From September 2012 to August 2015, 250 consecutive patients were treated with “all in-one” mesh hernioplasty procedure in our Institution. According to the devised technique, a new smaller prosthesis was placed on the floor of the inguinal canal in order to strengthen all areas of weakness from which hernias may originate. The mesh was enveloped by a fibro-cremasteric sheath avoiding contact with neural structures. Follow-up was carried out at 3, 6, 12, 18 and 24 months for evaluation of postoperative pain using Visual Analogue Scale score, need of medication, patients' comfort and short or long-term complications.

Results: All patients were discharged within 24 h from surgery. Slight pain was reported by the majority of patients and 47.6% of them did not require pain medication at home. After the 1st postoperative week 96.8% reported no pain and no other symptoms. No relevant limitation of normal activities was reported. There has been no postoperative neuralgia. One recurrence was observed.

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Conclusions: This new hernioplasty technique respects the anatomy of the inguinal canal, uses a smaller mesh, and seems to avoid neuralgia with maximum comfort for the patients. © 2017 Asian Surgical Association and Taiwan Robotic Surgical Association. Publishing services by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

1. Background

Since the Seventies, when biocompatible meshes were introduced with the consequent decrease of recurrence, one of the priority in inguinal hernia surgery was that of minimizing postoperative chronic pain.^{1–3} All technical variations, proposed during the past years in order to improve patient's comfort,^{4–6} reported a variable incidence of chronic neuralgia.^{1,3,7,8}

The procedure we describe, applicable to all cases of primary inguinal hernia, employs a smaller pre-cut single mesh that covers all weak areas of the inguinal canal and is enveloped in a fibro-cremasteric sheath, avoiding contact of the prosthesis with neural structures.

2. Methods

2.1. Population

We considered a cohort of patients suffering from primary unilateral inguinal hernia that underwent the "all-in-one" mesh hernioplasty technique consecutively, at our Institution. Hernias were divided according to the European Hernia Society classification.^{9,10} The work described has been carried out in accordance with the code of ethics of the World Medical Association (Helsinki declaration). Written informed consent was obtained from each patient included in the study. All data of the cohort were registered in a specific database. Spinal anaesthesia was adopted, and 2.0 g Cefazolin was administrated intravenously over 30 min before the incision for all patients, and the procedure was performed on a one-day surgery basis. From September 2012 to August 2015, we treated 250 adult patients for primary inguinal hernia, 241 males and 9 females with an average age of 61.7 years (range: 22–90). Hernias were classified according to the European Hernia Society criteria (Table 1).

2.2. Surgical technique

The following procedure employs a specific shape of mesh. The prosthesis consists in 3 sections: section A – ring-shaped portion designed to surround the deep inguinal orifice; section C – trapezoidal-shaped part of the mesh studied to lay on the floor of the inguinal canal; and section B – thin connection of the prosthesis between the two previously described sections (Fig. 1). The semi-resorbable mesh (synthetic absorbable monofilament in 70% polyglycolide and 30% polypropylene) is shaped by means of a plastic sterile template directly at the operating table. Any kind of other material may used to manufacture the mesh.

The technique does not require the identification nor dissection of any nervous structure lying beneath the aponeurosis. The ilioinguinal nerve is adherent to the external surface of cremaster in its more lateral part and the iliohypogastric nerve runs medially on the internal oblique muscle. The above nerve structures do not takes contact with the site of mesh positioning. The ilioinguinal and iliohypogastric nerves must be avoided in case of anatomical variations and isolated only if they interfere with the operation.¹¹ An oblique or transverse inguinal incision is made. The fascia of the external oblique muscle is opened and the spermatic cord is identified. A medial longitudinal incision of the fibro-cremasteric sheath (comprising the muscle itself and the external-spermatic fascia) is made with a diathermocoagulator (Fig. 2). The margins of the incision are held back by forceps and bluntly dissected from the underlying cord elements (Fig. 3).

The opened fibro-cremasteric sheath (from the medial incision to the inguinal ligament) is exposed and the mesh will be later covered by this anatomic structure. An upward traction of the spermatic cord allows dissection of the postero-medial portion of the fibro-cremasteric sheath (the so called "funicular mesenterium") left on the transversalis fascia for protection of the neurovascular bundle comprising the external spermatic vessels and the genital branch of the genitofemoral nerve.

Then the hernia sac is dissected from the cord elements and tucked away into the abdominal cavity and, according

Table 1 Hernias were divided according to the European Hernia Society classification.

Type	N. of patients
P L1M0F0	53
P L2M0F0	53
P L3M0F0	33
P L2M2F0	24
P L1M1F0	20
P L0M2F0	16
P L0M1F0	12
P L3M3F0	12
P L1M2F0	12
P L0M3F0	8
P L1M3F0	3
P L2M1F0	2
P L2M3F0	1
P L3M2F0	1

EHS classification: P = primary hernia; R = recurrent hernia; 0 = no hernia detectable; L = lateral hernia; M = medial hernia; F = femoral hernia; 1 ≤ 1,5 cm (one finger); 2 ≤ 3 cm (two fingers); 3 ≥ 3 cm (more than two fingers).

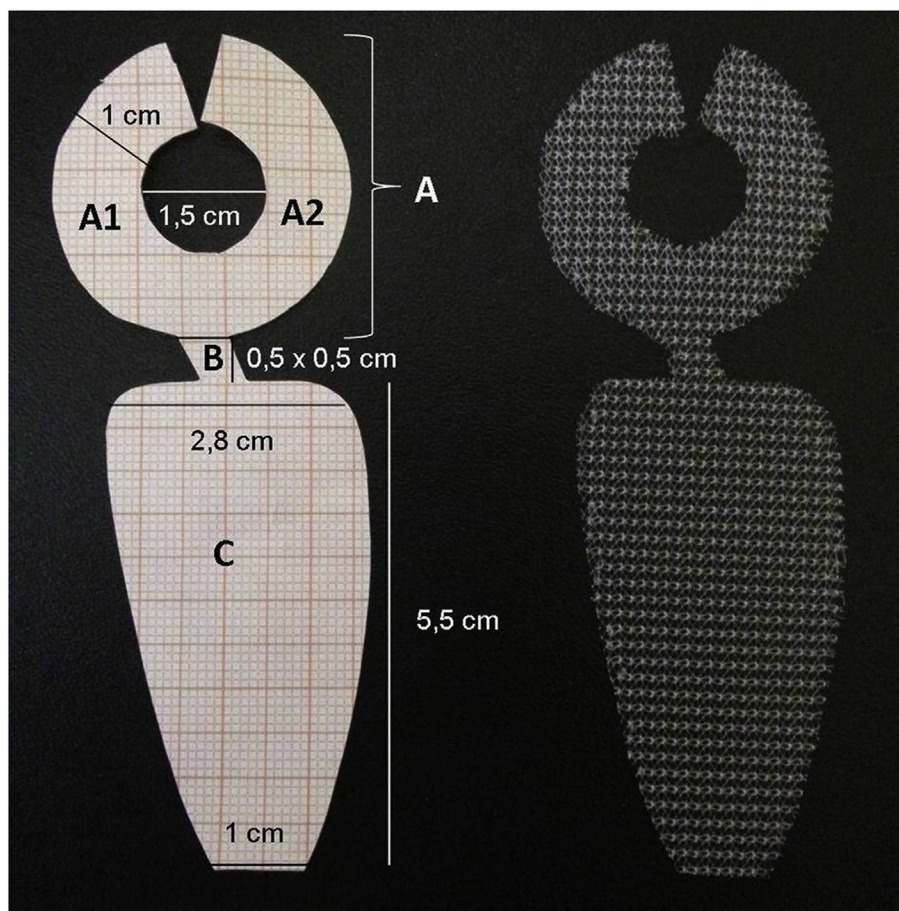


Figure 1 The design of 'all-in-one' mesh.

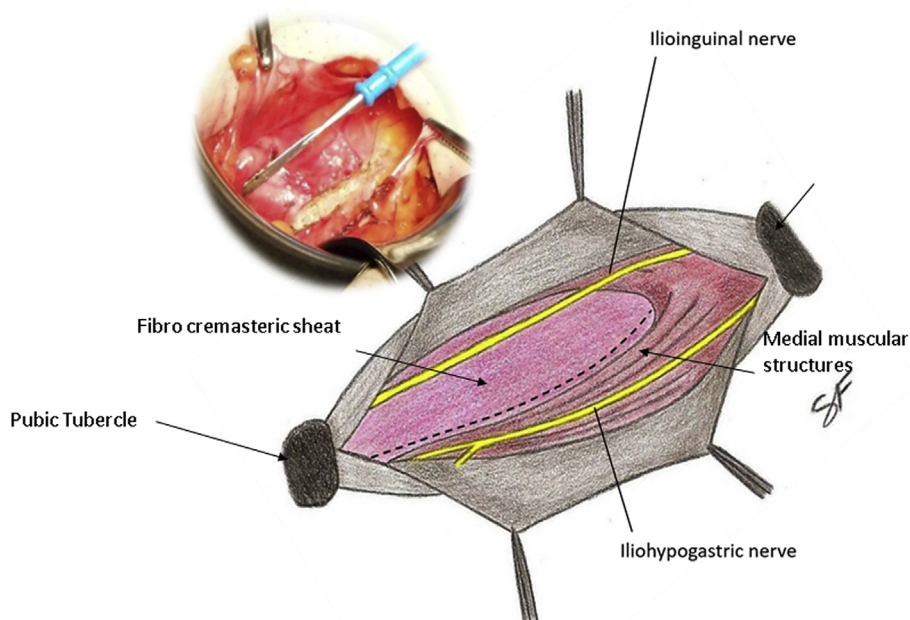


Figure 2 Medial longitudinal incision of the fibro-cremasteric sheath.

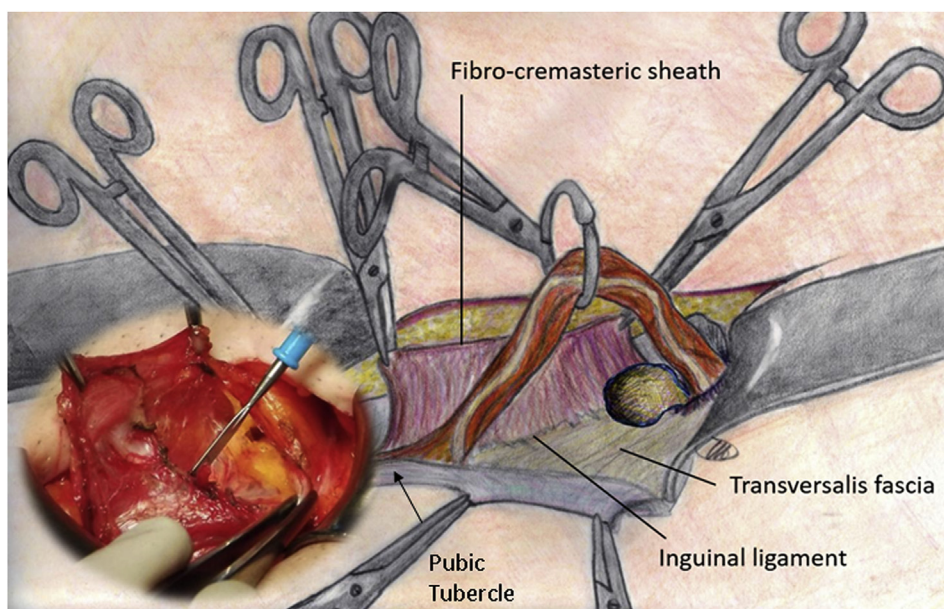


Figure 3 Fibro-cremasteric sheath dissection.

to the type of hernia, the transversalis fascia is plicated in order to strengthen it. The deep inguinal ring should always be prepared, even in case of direct or internal oblique hernia, in order to accommodate the section A of the mesh (Fig. 1). In inguino-scrotal hernias, when a very large internal orifice is present, the width of the ring is reduced beforehand by a few stitches. Section A of the prosthesis surrounds the spermatic elements by forming a conical ring

around them; this is obtained by stitching sections A1 and A2 together. The prosthetic ring is placed beneath the rim of the deep inguinal orifice strengthening the lateral weakness area (Fig. 4).

Sections B and C lie on top of the transversalis fascia. Section B exits the ring and fans out to form the C segment with a slightly medial direction, resting on the floor of the inguinal canal and strengthening the medial weakness area.

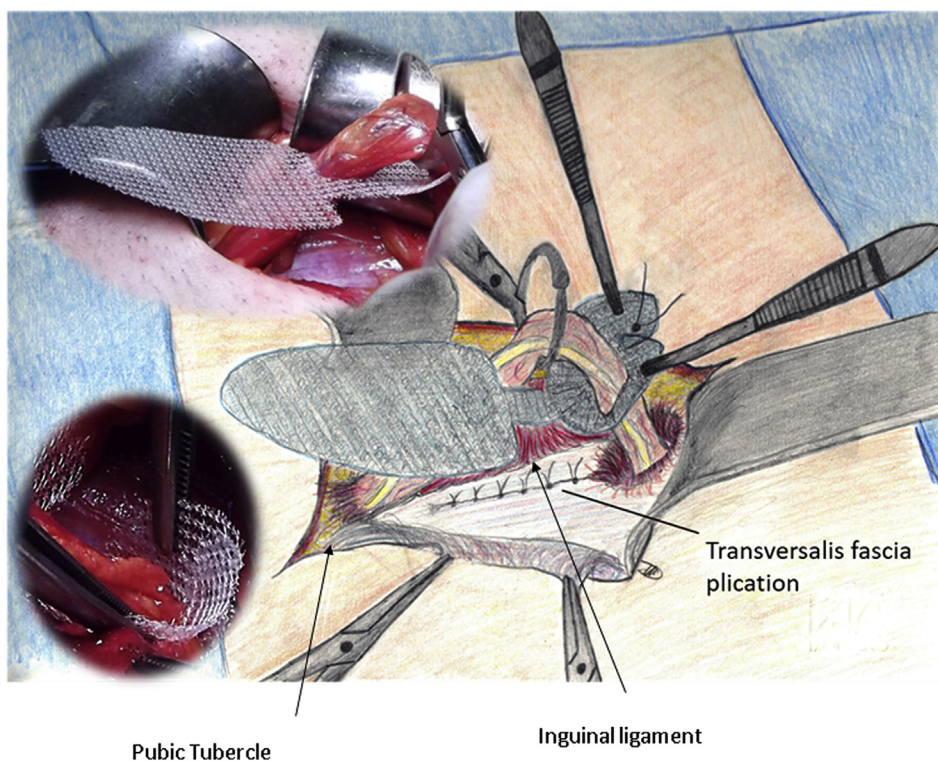


Figure 4 Introduction of the prosthetic ring (section A) in the deep inguinal ring.

Placed in such a manner, the prosthesis rests laterally with its lesser convexity on the inguinal ligament and extends to the conjoined tendon medially or even overlaps it, according to the patient's anatomy. An absorbable stitch closes the lower edge of the deep ring over the section B of the prosthesis; the narrowness of the section B avoids wrinkling of section C when the stitch is tightened. The tip of section C overlaps the pubic tubercle and is sutured in place avoiding the periosteum.

Then the medial margin of the fibro-cremasteric sheath is retrieved and transposed beneath the spermatic cord and, by means of a running absorbable suture, fixed to the medial muscular structures in order to cover the mesh (Fig. 5). The enveloped prosthesis will stay in place with no need of stitching it to adjacent structures. The cremaster also avoids adhesion between mesh and spermatic cord. Finally the cord is returned to its usual position and the aponeurosis of the external oblique muscle is sutured with absorbable material. Sandwiched between the fascia transversalis and cremaster, the prosthesis is held in place from the deep inguinal ring to the pubic tubercle. The shape of the prosthesis allows its use in both right and left-sided hernias.

2.3. Follow-up

Postoperative pain was gauged on the ward by a surgeon of the team. At discharge, all patients received a data sheet designed for the evaluation of postoperative pain using Visual Analogue Scale (VAS) score, quantity of pain medication, and any postoperative discomfort. The patient's discomfort was assessed in terms of limitation of daily activities during the postoperative period, and return to work, and sports. Patients were asked for an overall opinion on the operation, on the postoperative period and on the final result. These data were recorded by patients themselves on data sheet after one, two and three weeks from discharge.

The first clinical evaluation was made seven days after surgery by a member of the surgical team. The second and third week interviews were made on the phone. The postoperative data registered by patients were collected.

Follow-up, made to evaluate local signs, any kind of chronic pain, any sensation of foreign body and recurrence, took place at 3, 6, 12, 18 and 24 months after surgery in the outpatient clinic by a surgeon of the team. All patient data were collected in a database of our Institution.

3. Results

Three (1.2%) patients complained of urinary retention, 2 (0.8%) of orchitis and 14 (5.6%) showed bruising of the external genitalia. No other early complications were reported. Pain reported by patients in the immediate postoperative period was slight (mean VAS score = 2.1). Seventy-nine (31.6%) patients required no pain medication; while the remaining 171 (68.4%) were given non-narcotic analgesics.

Average VAS score during the first postoperative week was 1.2 (DS 1.5) and 119 (47.6%) patients took no medication. During the second postoperative week, 8 (3.2%) patients still complained of slight pain referred to the wound (average VAS score = 0.06-DS 0.4). None of patients took medication. During the third postoperative week, only 0.4% (1) of patients complained of slight pain (average VAS score 0.01-DS 0.07) which needed no medication.

Only 23 (9.2%) subjects experienced slight limitations of normal activities during the first week (Table 2). 30 (20.1%) patients were able to engage in sports as early as one week from surgery while 46 (30.9%) started between 7 and 21 days after surgery.

Patients underwent to planned follow-up at 3 months (50 patients), 6 months (35 patients), 12 months (25 patients), 18 months (35 patients + 1 patient lost) and 24 months (104 patients). Average follow up 15 months. None of our patients suffered from postoperative neuralgia, sensation of

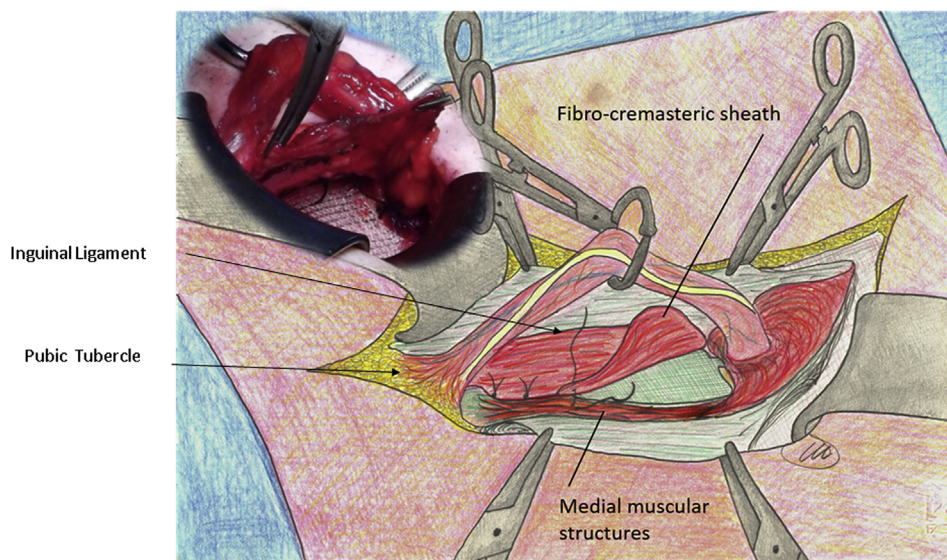


Figure 5 Covering of the mesh with the fibro-cremasteric sheath.

Table 2 Restriction in daily activities.

	1st week n. pt	2nd week n. pt	3rd week n. pt
No restriction	227	246	250
Slight restriction	23	4	0
Severe restriction	0	0	0

foreign bodies or even simply discomfort. One recurrence was seen. The patient was re-operated by laparoscopic approach (TAPP). All patients seemed satisfied with the operation, the recovery and the final result.

4. Discussion

Tension-free techniques dramatically reduced recurrence rates making them the standard in hernia surgery. A not negligible incidence of postoperative chronic neuralgia^{3,6–8} brought the attention of surgeons to new precautions even with the use of meshes.¹²

Postoperative pain is temporary, usually controlled by medication. When persistent after 3 to 6 months from surgery, pain becomes disabling and may compromise the patient's quality of life. Pain may be related to the presence of the mesh that, because of size and location, takes contact with muscular structures, or caused by fibrotic entrapment of nerves by a sub-fascial prosthesis.^{13–15}

Studies conducted on animals also showed perineural alterations with myelinic degeneration due to contact between nervous structures and mesh.¹⁶ Therefore, the necessity of identifying and dissecting sub-fascial nerves¹⁷ and even of dividing them to avoid chronic pain.^{18,19}

New surgical techniques and numerous kinds of meshes were proposed in the past years in the attempt to reduce

postoperative neuralgia; nevertheless the results of these new procedures were not completely satisfactory.^{4–6,20,21} This led to the setting of guidelines for prevention and treatment of this situation.²²

If we consider the areas of weakness within the inguinal canal from which the three types of hernia arise, we see an oval shaped surface surrounded by known muscular and fascial structures on the canal's floor and a further weak zone in proximity to the deep inguinal ring (Fig. 6).

The transversalis fascia is an important restraining element for both structure and functionality in a region lacking overlying muscular structures. Then, the idea of a prosthesis specifically shaped to obtain containment by acting directly on the weak areas of the transversalis fascia without involving muscular or nervous structures avoiding to place a sub-aponeurotic mesh. This allows the procedure more anatomical with minimal foreign body implantation. The prosthesis size, defined after numerous measurements of the inguinal canal made at the operating table, is notably smaller than the ones used as of now, allowing a precise and smooth positioning in a different plane to where the nerves lie.

The weak areas along the transversalis fascia are strengthened, all at once, by the prosthesis (all-in-one mesh), so that losing a hernia sac can no longer happen.²³ Polypropylene was chosen because of its capacity of inducing a lively inflammatory and fibrotic response with quick and strong adhesion to adjacent tissues. A prompt fibroblastic reaction between transversalis fascia and mesh, immediately takes place because of the absence of any dead space, quickly forms a new wall.

This new technique is simple to perform and guarantees quick discharge and return to normal activities without any long term discomfort. The average operative time was 25 min. The surgeon needs not dissect the cremaster, which may cause damage to the nerves, nor create a sub-fascial

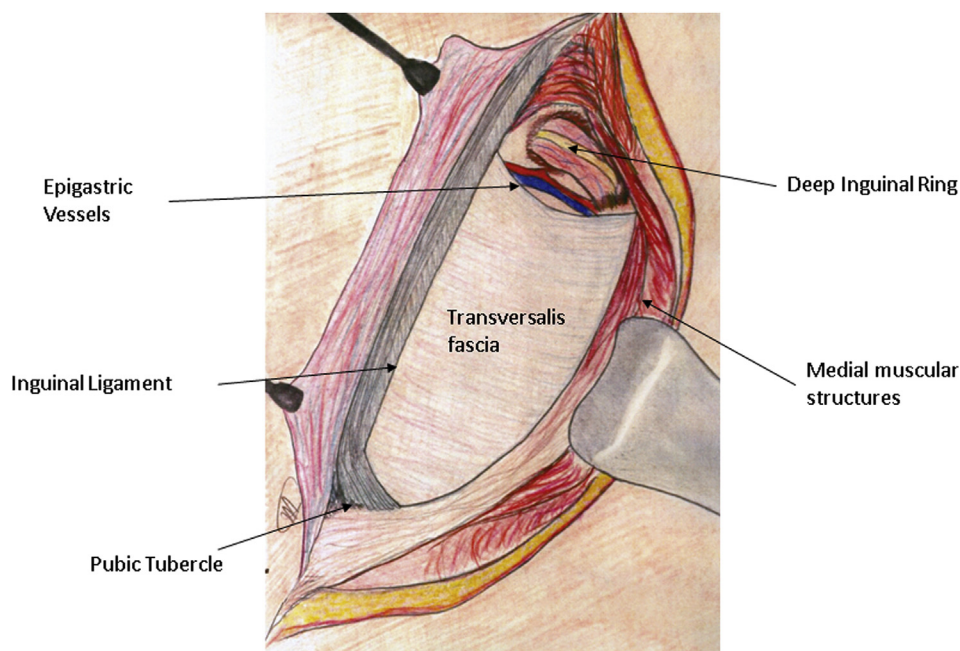


Figure 6 Areas of weakness in the inguinal canal.

"nest", because no mesh is inserted at that level. Furthermore, no plugs nor mesh trimming are necessary and the prosthesis does not have to be sutured to adjacent structures. The use of a smaller quantity of prosthetic material allows the envelopment of the mesh by the fibro-cremasteric sheath, avoiding contact with surrounding nerves. Because of its shape, the mesh is placed in a deeper site directly over the weak areas of the floor of the inguinal canal and, although smaller, it seems not increase rate of recurrence.

The most common technique of Lichtenstein provides a prosthesis which, to remain on the transversalis fascia, must be fixed to the sides and becomes necessarily under aponeurotic in the upper third.

In our technique, the prosthesis is positioned and remains on the transversalis fascia because it is coated with the fibro-cremasteric sheath and it remains anchored on the inguinal floor with a single fixing point at the pubic level and with the prosthetic conical ring on the deep inguinal ring. It is not directly under-aponeurotic at any point, it stays in place and therefore does not require lateral fixation.

In addition, the prosthesis is not in contact with the ilio-inguinal and ilio-hypogastric nerves. Our paper is an observational cohort study with only mid-term (two years) follow-up. Clinical trials comparing the "all-in-one mesh" hernioplasty to the most common surgical techniques are required to obtain a validation of our procedure. Indeed, a much longer follow-up could highlight the actual recurrence rate of the new procedure.

5. Conclusions

This new procedure claims many technical advantages and helps the less experienced surgeon to avoid pitfalls in dealing with nerves. According to our series, "all-in-one mesh" hernioplasty presents a low rate of long term complications. Employing a smaller amount of prosthetic material, placed where no contact with nerves occurs, avoids neuralgia and sensation of foreign body. A multicentre study, with long term follow-up, is needed to compare this new procedure with the most common techniques.

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