



The minimal open preperitoneal (MOPP) approach for treating groin hernias: technique, indications, and results

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Background: Over recent decades, surgical treatments for groin hernias have been largely categorized into the endoscopic posterior approach and the classic Liechtenstein-type anterior approach. A newer third approach, termed the open preperitoneal, has emerged. Numerous studies over the years have highlighted its benefits and efficacy. Here, we provide a detailed step-by-step description of the minimal open preperitoneal (MOPP) technique, a variant of these approaches. This method involves the placement of a large mesh in the preperitoneal space through a minor incision. It represents a fusion of the transinguinal preperitoneal technique (TIPP) and the Ughary technique.

Methods: The primary innovation of this paper is the meticulous delineation of surgical anatomy, focusing on the fascia transversalis that envelops the deep inguinal orifice and forms the internal spermatic fascia. This precision enables clear definition of crucial steps in the technique, facilitating its teachability and reproducibility. Another significant contribution of this work is the presentation of results based on a large patient cohort, monitored over a two-year period. All consecutive MOPP procedures performed by the author during the study timeframe were registered in the Hernia club registry. Data points included demographics, baseline pain status, perioperative details, hospital stay, early outcomes up to day 30, follow-ups, long-term outcomes, and patient-related outcomes measures (PROM).

Results: Between September 2011 and April 2019, the author performed surgeries on 1,616 groin hernias. Out of these 1,401 hernias (spanning 1,146 patients) were treated using the MOPP procedure. A total of 1,316 patients were treated on an outpatient (93.4%), 77 cases (5.51%) of post-operative complications were noted classified under Dindo-Clavien grades I and II. No reoperation was necessary. On the thirtieth postoperative day 1,228 patients were checked, 915 patients had a Visual Analog Scale (VAS) equal to 0 (74.51%), VAS 1–3 for 260 patients (21.17%), VAS 4–6 for 43 patients (3.50%), VAS 7–10 for 10 patients (0.81%). At 3 months 56 patients reported a VAS score greater than 0 for 20 patients the pain was greater than the preoperative pain. The overall rate of chronic pain was therefore 1.43%. Two recurrences were noted.

Conclusions: The MOPP technique, a minimally invasive open preperitoneal procedure, offers a sutureless and tension-free total groin hernia repair. It gives an excellent outcome, characterized by minimal chronic pain, recurrence, and complication rates.

Keywords: Prosthesis; open preperitoneal; minimal open preperitoneal (MOPP); groin hernias

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Introduction

Background

The idea of utilizing a large preperitoneal prosthesis for the treatment of groin hernias was extensively advocated over 60 years ago by Nyhus (1). Notwithstanding, the principle of the preperitoneal “hammock prosthesis” as a treatment for groin hernias can be traced back to the thesis of French surgeon D. Corti in 1949, building on the work of E. Acquaviva (2-4). Wantz (5,6) shared a similar concept, introduced a trans-rectus procedure aiming to treat complex hernias (such as recurrent hernias) using local anesthesia in an ambulatory setting. Regrettably, due to technical challenges, and even by his own admission, this objective was not attained. The Wantz procedure eventually necessitated general anesthesia and traditional hospitalization. Inspired by Wantz and Stoppa (7), Franz Ugahary, the pioneer of the minimal open preperitoneal (MOPP) approach, realized this goal. He merged the

concept of fortifying the visceral sac with a large prosthesis (as proposed by Stoppa) with his innovative minimal invasive surgery utilizing a small grid iron incision (8,9). However, many found the Ugahary technique challenging to replicate and teach. The technique did not gain widespread adoption, partly due to the absence of a prosthesis specifically designed for the minimal incision. Over the past two decades, with the rise of endoscopic surgery, inguinal hernia treatments have largely been divided into two primary techniques: the classic anterior Lichtenstein-type approach and the posterior endoscopic approach. However, a new prosthesis developed by Pelissier, featuring a rigid peripheral ring, made it easier to place the mesh in the preperitoneal space through an anterior approach. This innovation led to the birth of the transinguinal preperitoneal (TIPP) technique (10,11), the second minimal invasive open preperitoneal method following the Ugahary technique. The third variant is denoted by the trans-rectus preperitoneal (TREPP) technique (12). It is only in recent years that studies have emerged comparing this open preperitoneal method to the earlier two (13-19). The open preperitoneal approach has proven superior to the Lichtenstein techniques in terms of reducing chronic pain and has displayed results on par with endoscopic methods.

Highlight box

Key findings

- Minimal open preperitoneal (MOPP) technique is a newcomer in the group of open preperitoneal techniques after trans inguinal preperitoneal and trans rectus preperitoneal techniques. We have presented a very detailed description of the technique, step by step. The MOPP technique has demonstrated good results in terms of chronic pain and recurrence rate. The technique it neither requires disposable equipment nor gas, it is environmentally friendly.

What is known and what is new?

- The two classic groups of primary groin hernia repair techniques Lichtenstein and endoscopic have often been compared ultimately indicating better results for the endoscopic group with regard to chronic pain. More recently the comparison between open preperitoneal techniques and the two classic groups shows a superiority of this third group versus Lichtenstein with at least as good a result as the endoscopic techniques.
- This manuscript adds to the last publications a proposition of a new preperitoneal technique as a basic intervention for primary groin hernias.

What is the implication, and what should change now?

- The major implication is to be able to offer MOPP for surgeons who are unwilling or unable to use endoscopic equipment. Or as a substitute technique for endoscopic surgeons who do not wish to perform their usual technique for some select patients while also avoiding the Lichtenstein technique or the no mesh repair technique. But it will be necessary to confirm the good results presented in this study by those which will have to be presented by new users.

Objectives

The objectives of this article are two-fold:

- (I) To provide a revised description of the MOPP technique. While the origins, technical principles, and preliminary outcomes of the MOPP method have been previously published (20,21), this article clarifies several fundamental steps of the procedure based on cadaveric dissection and the clinical experience from several thousand surgeries. The innovation hinges on the identification of the transversalis fascia (TF) during two pivotal stages: The TF covers the deep inguinal orifice. Recognizing it at this juncture initiates the entry into the preperitoneal space, paving the way for preperitoneal dissection. The TF also constitutes the internal spermatic fascia. Identifying and severing it systematically commences the parietalization of the cord elements in medial hernias. Rationalizing these two essential steps for placing a large prosthesis in the preperitoneal space makes the technique more easily reproducible and teachable.

(II) This article, for the first time, presents results from a substantial number of hernia repairs [1,401] using the MOPP technique. The data are sourced from the French “club hernie” database (22). The aim is to highlight the technique’s impressive outcomes in terms of minimal short and long-term complications, its low recurrence rate, minimal chronic discomfort, and the virtual absence of severe chronic pain when addressing primary groin hernias. I present this article in accordance with the STROBE reporting checklist (available at <https://ales.amegroups.com/article/view/10.21037/ales-23-37/rc>).

Methods

Prospective data

Patients included in the study: all primary, inguinal, femoral hernias and bilateral hernias in both men (including scrotal hernias) and women. Patients excluded from the study: strangulating hernias, unscheduled surgeries, and according to the HerniaSurge Group International guidelines (23), placing a mesh in the preperitoneal space is contraindicated if the posterior route has been previously used. Therefore, previous radical prostatectomy, pelvic irradiation, or the performance of a vascular bypass with dissection of the preperitoneal space are contraindications to the MOPP technique. As the MOPP technique is a preperitoneal route through the anterior wall, recurrent hernias are mostly contraindicated. When a strictly posterior approach is preferable, I employ the Ugahary technique [similar to endoscopic totally extraperitoneal (TEP) technique]. Our patients are informed of the necessity for long-term follow-up and data collection. The data have been integrated into the database of the “hernia club” following a rigorous methodology and a binding charter (22).

Between September 2011 and 29 April 2019, a total of 1,616 groin hernias were operated on in a single center by a single operator. A total of 1,500 were primary hernias, and 1,401 hernias (out of 1,146 patients) were operated on using the MOPP technique. During this period, 171 primary or recurrent hernias were operated on using other techniques: Ugahary (N=91), Lichtenstein and anterior mesh (N=64), posterior mesh (N=5), and no mesh (N=4).

Clinical control is performed by the operating surgeon at discharge, the tenth postoperative day, the thirtieth postoperative day and, in the case of any symptoms at one month, an additional visit is scheduled between the

third and sixth months post-surgery and 1 year after the procedure. During face-to-face interviews, pain was assessed using the Visual Analog Scale (VAS): 0 to 10 for D0, D1, D8, D30, D90–180 if pain persisted at D30, and 1 year later. An additional follow-up at 2 years involves a phone interview following a validated phone questionnaire conducted by an independent clinical research assistant (CRA) shielded as to the surgical procedure deployed. During the phone interview at 1 and/or 2-year follow-up, since VAS was not applicable (not face-to-face), we utilized a four-level verbal rating scale (VRS)—no pain, mild pain, moderate pain, severe pain. Post-operative VAS and VRS scores were compared to the preoperative scores. If any event is reported over the phone, the patient is strongly advised to schedule a clinical visit.

Collected parameters

Data extracted from the registry included perioperative data such as patient age and gender, body mass index, comorbidities, hernia and operative characteristics, operating time, and length of stay. Post-operative outcomes occurring within the first 30 days post-surgery were noted. Complications were graded based on the Dindo-Clavien classification. Late outcomes and follow-up: at each follow-up stage, quality of life (QOL) and patient self-assessment of the surgery (PROM) were documented.

Pain assessment

Chronic postoperative pain is defined as pain lasting more than 3 months. To mitigate bias in data collection and results, it’s noteworthy that all eligible patients operated on during the study period were included without exception.

Statistical analysis

Categorical variables were presented as frequencies and percentages. We do not have a comparative analysis in this study.

Ethical statement

The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). As this study is a monocenter, monoperator observational retrospective study, embedded in a registry which complies with the General Data Protection Regulation (GDPR) and the

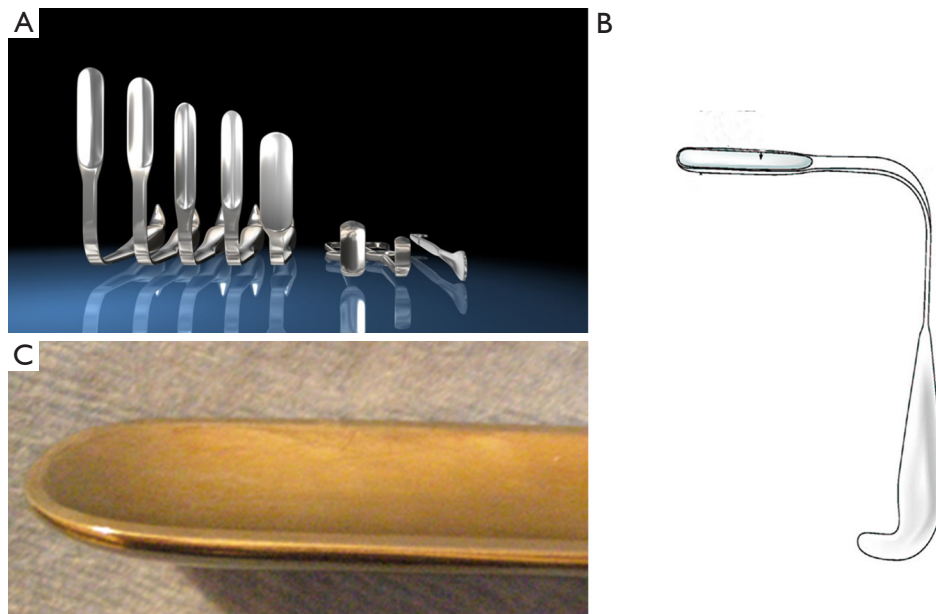


Figure 1 Set of instruments specifically used according to Ugahary's dissection principles. (A) Different size of dissectors and retractors. (B) See the narrow aspect of the device which allows the dissection through the small incision. (C) See the atraumatic concave appearance of the active part of the instrument.

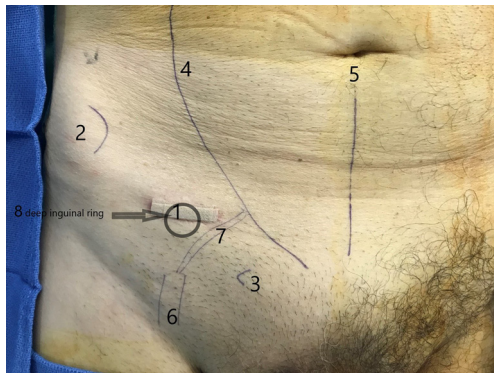


Figure 2 Skin incision: 1, incision cover with the strip; 2, antero-superior iliac spine; 3, pubic spine; 4, lateral border of the right muscle; 5, the midline; 6, projection of the femoro-iliac artery; 7, projection of the inferior epigastric vessels; 8, the deep inguinal ring.

French “Commission Nationale de l’Informatique et des Libertés” (National Commission for Information Technology and Liberties) CNIL (MR0003) requirements, IRB approval is not required. Informed consent was taken from all the participants.

Surgical technique

Preliminary considerations

Minimal open and minimally invasive technique: The MOPP technique proposed here in is a synthesis between the TIPP technique, from which it uses the principles (10,11), and the Ugahary technique (8,9), from which it uses the same dissection technique of the planes with specific retractors of different sizes (*Figure 1*). This combination, based on our experience, typically limits the incision to 3 or 4 cm, hence the term “Minimal Open” (*Figure 2*). The operation can be performed under ilioinguinal block, transversus abdominis plane (TAP) block, or spinal anesthesia. In our practice, we now use general anesthesia without endotracheal intubation or curarization; local anesthesia is also applied, illustrating the “minimal invasive” principle. The “Minimal Open” and “minimal invasive” principles rationalize our preference for this technique when treating older and more fragile patients, even those with the largest primary hernias. The main principle of MOPP is to unroll in the preperitoneal space a large prosthesis far beyond the limits of the Fruchaud musculo-pectineal hole (24). It is a suture-less and tension-free technique. The prosthesis is held against the abdominal

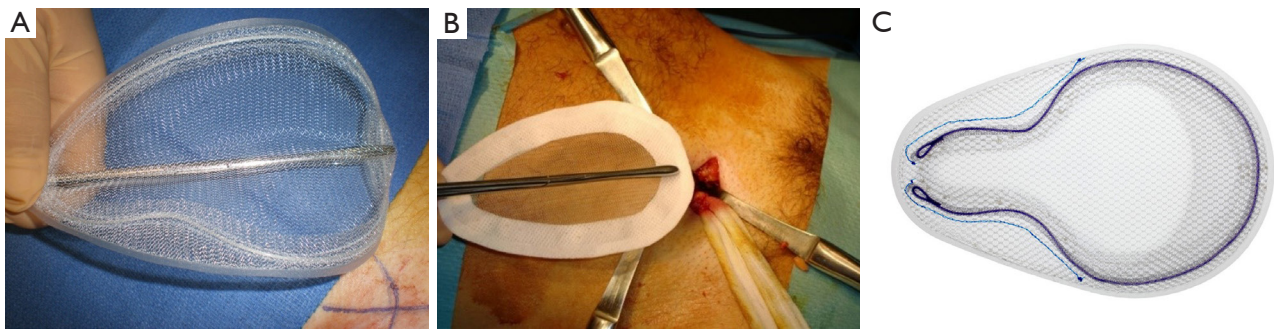


Figure 3 Examples of prostheses dedicated to the open preperitoneal technique. (A) An ovoid polypropylene mesh with a non-absorbable peripheral ring. (B) Polypropylene Ovoid mesh with a peripheral reinforcement in the form of a hem. (C) Polypropylene Ovoid mesh with an absorbable peripheral ring.

wall by the underlying pressure. Whenever the general conditions allow, the procedure is scheduled as outpatient (more than 90% in our practice).

Prosthesis-instrumentation

The prosthesis is chosen based on the need to unroll it in the preperitoneal space through a small incision. Some wide polypropylene mesh prostheses are specifically designed for this technique, with peripheral reinforcement, facilitating the proper deployment of the prosthesis (Figure 3). The quality of the prosthesis supports the minimally invasive approach. This technique requires very long but narrow retractors (Figure 1), allowing for extensive and deep dissection. A long dressing forceps with an atraumatic end is used to introduce the prosthesis behind the pubic bone, in contact with the bladder, without risking trauma.

Surgical technique step by step

We use the new Fascial nomenclature (25) to describe the planes between the skin and the external oblique fascia in the inguinal area: the tela subcutanea (Figure 4). The superficial adipose plane is the new name for Camper's fascia. The membranous plane has been renamed from Scarpa's fascia. The fat between the membranous plane and the external oblique aponeurosis is the pre-aponeurotic fat.

The skin incision

The skin incision is deliberately minimized. With experience, it can range between 25 and 40 mm. It is located immediately in front of the deep inguinal ring. Several landmarks can be drawn on the patient's skin (Figure 2). It is simpler to connect the superior anterior iliac spine to the pubic tubercle and mark the incision

transversely at the junction of the internal and middle third (Figure 5).

The incision of the subcutaneous tissue (tela subcutanea)

Refer to the diagram illustrating the surgical anatomy from the skin to the external oblique muscle aponeurosis (Figure 4), per the new anatomical nomenclature of the fascia (25). After dissecting the superficial adipose plane, previously known as Camper's fascia, we observe a membranous plane, formerly called Scarpa's fascia, which is sometimes a very thin membrane that can be hard to discern (Figure 6). This structure varies between individuals. The membranous plane is incised transversely (Figure 7). It will be sutured with a thin absorbable thread at the end of the procedure. Beneath the membranous plane, an adipose plane must be dissected to visualize the external oblique muscle aponeurosis.

External oblique muscle aponeurosis incision

Cranially and laterally, the fibers of the aponeurosis typically form a thick, sturdy ligament. Caudally and medially, they often appear disorganized, closing the upper pole of the superficial inguinal ring (Figure 4). The incision of the aponeurosis is oblique, downwards and inwards, centered over this area where the fibers are disorganized and situated above and outside the superficial inguinal orifice. It's not necessary to open the orifice (Figure 4). At this point, the ilioinguinal nerve can be identified. Care must be taken not to cut it during the aponeurosis incision (and similarly when closing it). With the incision, the inguinal canal is now wide open, but the cord is not immediately visible as it's covered by cremaster fibers (Figure 8). The cremaster

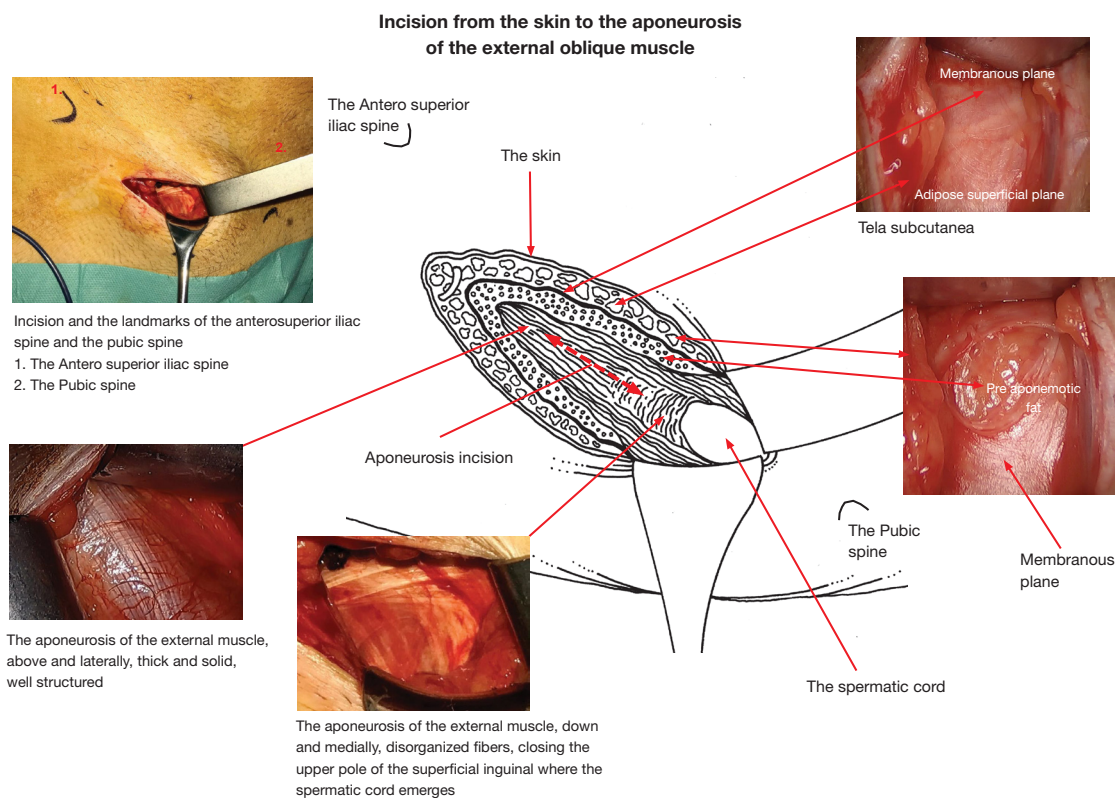


Figure 4 The incision of the tela subcutanea. The surgical anatomy from the skin to the external oblique muscle aponeurosis. The dotted arrow indicates the position of the incision of the aponeurosis of the external oblique muscle.



Figure 5 Bilateral hernias, transverse incision at the union of the median and internal third of the line uniting the superior anterior iliac spine and the pubic spine.

fibers are situated between the external spermatic fascia, which originates from the external oblique, and the internal spermatic fascia, derived from the TF (26). While the appearance of the cremaster muscle varies significantly

among patients—sometimes thick with organized fibers or sometimes consisting of a few scattered fibers—the fibers are always preserved and pushed medially.

Dissection of the spermatic cord, the funicular pedicle, and the genital branch of the genito-femoral nerve

From the aponeurosis of the external oblique muscle laterally, the cord is moved medially to reveal the funicular pedicle (blue line) laterally and posteriorly, which contains the genital branch of the genitofemoral nerve that must be carefully preserved (Figure 9). The funicular pedicle is separated from the spermatic cord, and the posterior part of the cord is separated from the inguinal canal.

The cremaster muscle

The fibers of the cremaster muscle, which more or less densely cover the anterior surface of the cord, are pushed inwards, revealing the spermatic cord also covered proximally by the internal spermatic fascia, an extension of the TF. Typically, at this stage, the external spermatic fascia is not distinguished (26). As Fruchaud noted, it's possible

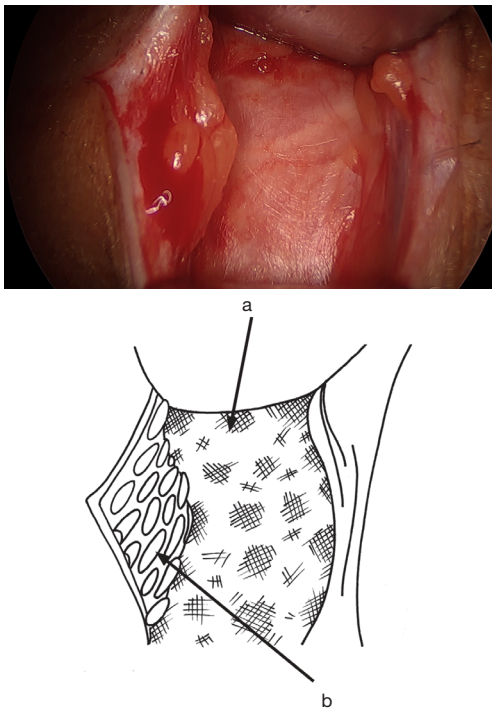


Figure 6 Tela subcutanea, the membranous plane. a, the membranous plane; b, the adipose superficial plane.

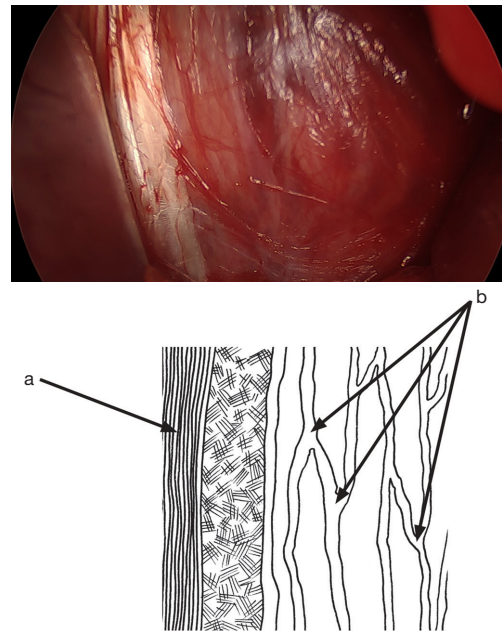


Figure 8 The inguinal canal is open. The spermatic cord is not spontaneously visible, covered by the external spermatic fascia and some scattered cremaster fibers. a, the external oblique muscle aponeurosis; b, scattered cremaster fibers.

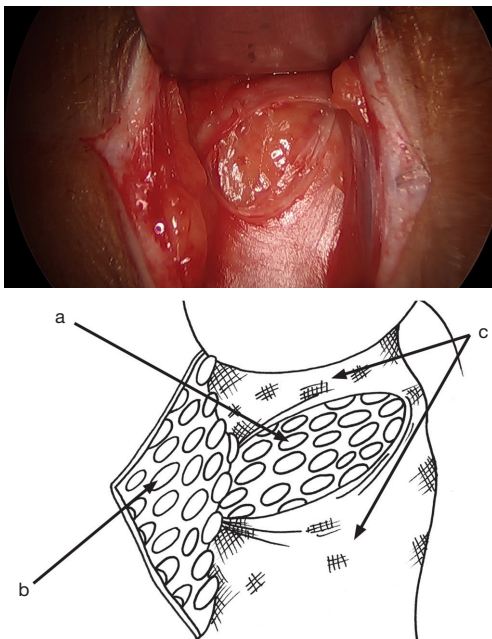


Figure 7 Tela subcutanea, incision of the membranous plane. a, preaponeurotic fat; b, the adipose superficial plane; c, the membranous plane.

to perform an intra-fibrocremasteric cleavage of the cord and free the cord elements from the fibrocremasteric sheath surrounding them. Fruchaud divided the main lateral fascicle of the cremaster laterally and the deep accessory fascicle medially (27). For this technique, I begin near the external oblique aponeurosis and gradually push all cremasteric fibers inwards as a block. They remain intact medially, and the spermatic cord is entirely dissected, only covered by the internal spermatic fascia (Figure 10).

Lateral sac, lipoma

At this stage, a lateral hernia sac is looked for. Identifying a large, old sac is easy, but sometimes a small sac is found in the cord’s most proximal part. The lateral sac is separated from the cord. Similarly, a lipoma of the cord is also dissected (Figure 11). It’s either repressed or resected, as retaining such a lipoma may cause postoperative pain and give the impression of a recurrence. At this stage, one can begin the parietalization of the cord by pushing back the hernia sac, or if there’s no lateral sac, by pushing the peritoneum’s line of reflection after sectioning the internal spermatic fascia, as we’ll examine in more detail during the

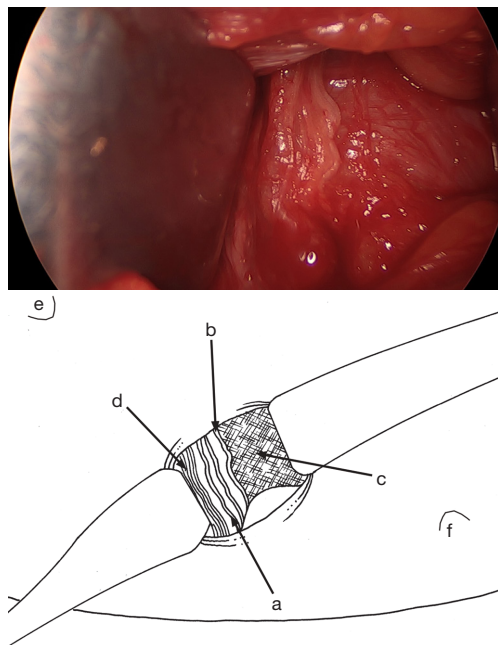


Figure 9 Separation of the funicular pedicle from the spermatic cord. a, funicular pedicle the vessels; b, funicular pedicle the genital branch of genitofemoral nerve; c, spermatic cord; d, external oblique muscle aponeurosis; e, Antero superior iliac spine. f, pubic spine. The funicular pedicle is pushed back and separated from the spermatic cord, then the posterior surface of the cord is released from the deep surface of the inguinal canal.

parietalization step.

The deep inguinal ring

In the MOPP technique, the preperitoneal route always passes through the deep inguinal ring, regardless of the hernia type: lateral, medial, or femoral. Thus, it's crucial to detail the methods of penetrating the deep inguinal orifice before releasing the preperitoneal space.

An essential point is that the TF covers the deep inguinal orifice. The approach is to push it inwards, starting from the internal edge of the spermatic cord or the internal edge of the lateral sac. Gradually, the yellow fat of the preperitoneal space becomes visible (*Figure 12*). Repeating this same pushback motion inside the TF, more yellow fat is seen, and the inferior epigastric pedicle (artery and veins) emerges (*Figure 13*). These vessels constitute a crucial landmark before entering the preperitoneal space. Preparing for this step, it's beneficial to study the TF through cadaver dissection (*Figure 14*). The dissection continues behind the vessels, first with a nut (*Figure 15*). Then the vessels

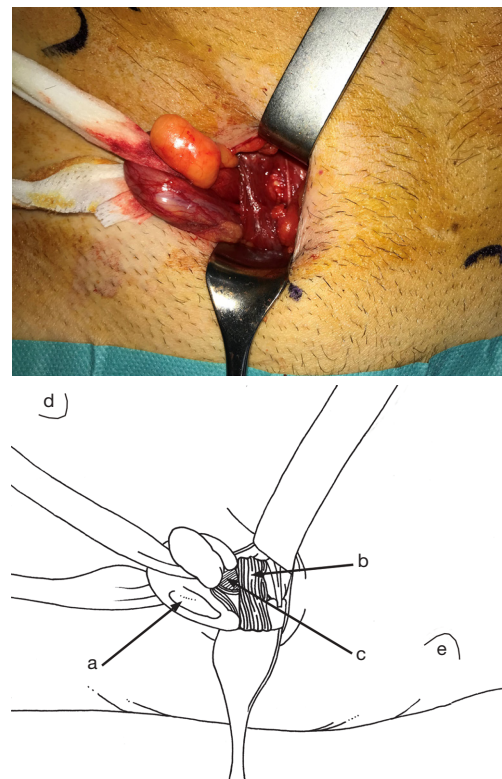


Figure 10 The spermatic cord is completely dissected, medially the cremaster fibers. a, the cord; b, the body of the cremaster muscle pushed inwards; c, the position of the deep inguinal ring covered by the transversalis fascia; d, the antero superior iliac spine. e, the pubic spine.

are pressed against the anterior abdominal wall, protected throughout the procedure with a retractor.

Cleavage of the preperitoneal space

As soon as the dissection passes medially beyond the deep side of the inferior epigastric pedicle, the conditions are met for extensive release of the preperitoneal space, where the lower and internal part of the mesh will be positioned. Using retractors specifically designed for the procedure, and increasing the sizes of retractors as per Ugahary's dissection principles (*Figure 1*), the dissection extends into the avascular plane, medially and laterally along the inferior epigastric vessels towards the iliac vessels. Quickly and easily, the Bogros and Retzius spaces are dissected, revealing the pubis, Cooper's ligament, and the retropubic space, with the bladder pushed back (*Figure 16*). During this stage, a medial sac may be repressed, and a femoral sac, if present, is always sought and repressed if necessary. Sometimes,

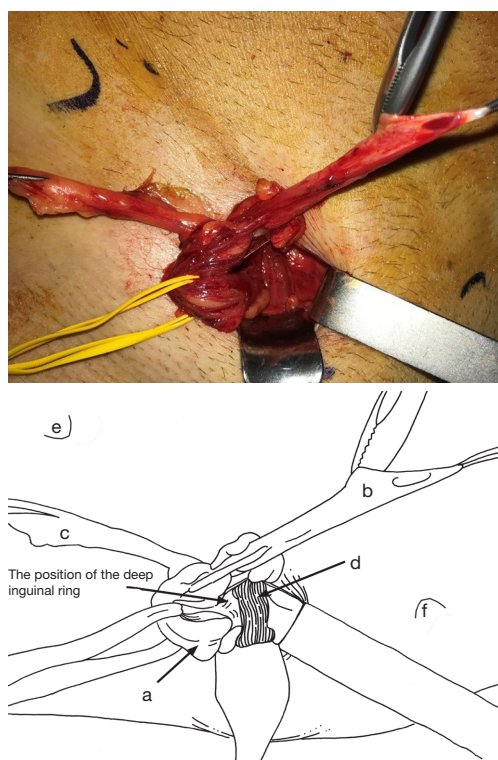


Figure 11 Externalization of the spermatic cord, individualization of a lateral sac, of a lipoma, the cremaster fibers retracted medially. a, the cord; b, the hernia lateral sac; c, a lipoma; d, the cremaster fibers; e, the Antero superior iliac spine; f, the pubic spine.

this is just a small lipoma incarcerated in the femoral ring. The obturator region is also systematically checked. The dissection is atraumatic for the pelvic vascular structures. The space's dissection continues upwards and medially. Above the incision, the peritoneal and fascial planes might adhere more or less to the superficial aponeurotic plane. Occasionally, dissection with scissors may be necessary to ensure proper deployment of the prosthesis at this level. Above and laterally, dissection is easier up to the psoas muscle.

Parietalization of the spermatic cord (visualization of the internal spermatic fascia)

This is a critical step for the proper deployment of the prosthesis. Complete parietalization is essential and its realization is delicate. As Wantz mentioned, the elements of the spermatic cord must be separated from the peritoneum over approximately 10 cm from the deep inguinal ring (5,6), preserving the spermatic fascia as indicated by Stoppa (28),

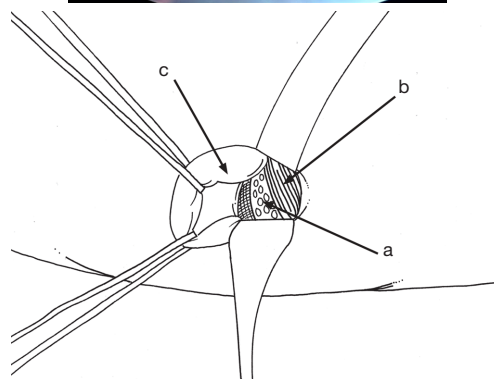
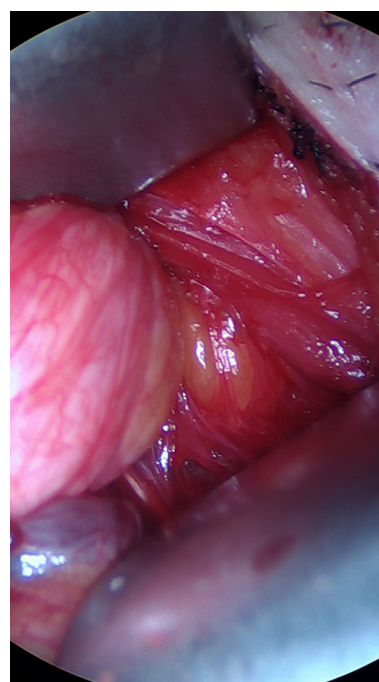


Figure 12 Penetration through the deep inguinal ring: the yellow fat. a, the preperitoneal yellow fat; b, the cremaster fiber; c, the spermatic cord.

thus achieving the cord's parietalization (*Figure 17*). If there's an external oblique sac already separated from the spermatic cord, the dissection will merely prolong the separation of the spermatic cord from the visceral sac upwards. Without a lateral sac, finding the correct plane might be more challenging. In such situations, it's crucial and straightforward to individualize the internal spermatic fascia. Cutting the internal spermatic fascia just before the spermatic cord penetrates the deep inguinal ring will open the plane between the spermatic cord and the visceral sac, without risking opening the peritoneum. Preparing for this step with cadaver dissection can be beneficial (*Figure 18*).

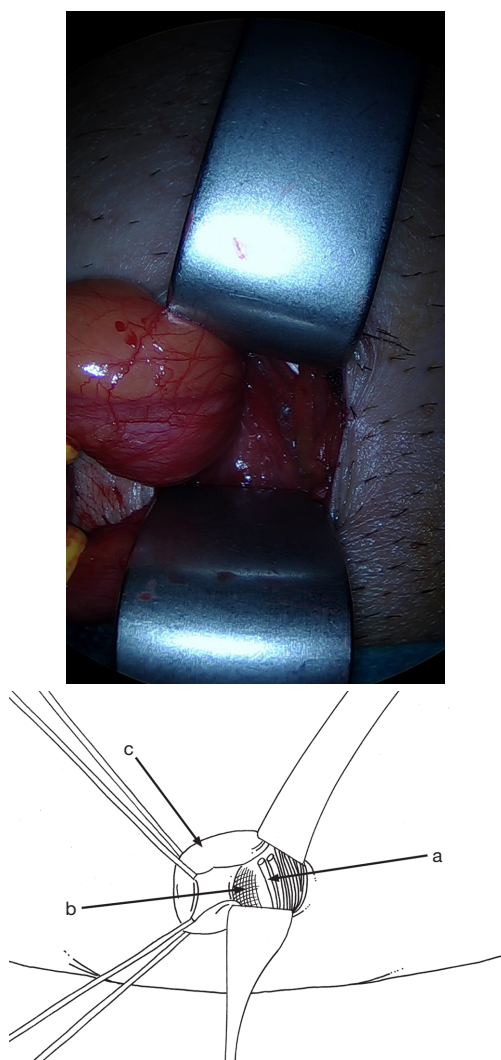


Figure 13 Visualization of the inferior epigastric vessels. a, Inferior epigastric vessels; b, deep inguinal orifice; c, the spermatic cord.

At this level, the vas deferens might closely adhere to the peritoneum. It is the sectioning of the internal spermatic fascia that facilitates the separation of the vas deferens from the peritoneum. After starting the parietalization this way, it then becomes easy to entirely separate the elements of the spermatic cord from the visceral sac, with a low risk of opening the visceral sac. The dissection can begin with a nut. The separation is then performed with specific retractors/dissectors according to Ugahary's principles. A deeper skin retractor can replace the original one, facilitating the dissection's progress. Applying a compress can also help push the visceral sac upwards. During this step, the dissection should respect the spermatic fascia if possible. The dissection is complete when the so-called "parietalization triangle" becomes visible (*Figure 17*). Its base is the line of reflection of the repressed peritoneum, and its peak is the reunification of the spermatic vessels with the vas deferens at the formed spermatic cord's level. The internal edge is limited by the deferent, which plunges backward and inward. The outer edge consists of the spermatic vessels. According to Stoppa, careful preservation of this "spermatic sheath" during the cord's mobilization is recommended to avoid perivascular sclerosis due to contact with the large mesh. This might be potentially useful if a reoperation is needed for vascular surgery, organ transplant, or lymph node dissection (28). This extensive dissection then allows the wide and easy deployment of the prosthesis's upper and external parts. This might explain our low recurrence rate.

Placing the prosthesis

We utilize a mesh with peripheral reinforcement, available in two sizes: medium (3.4×5.6 inches) and large

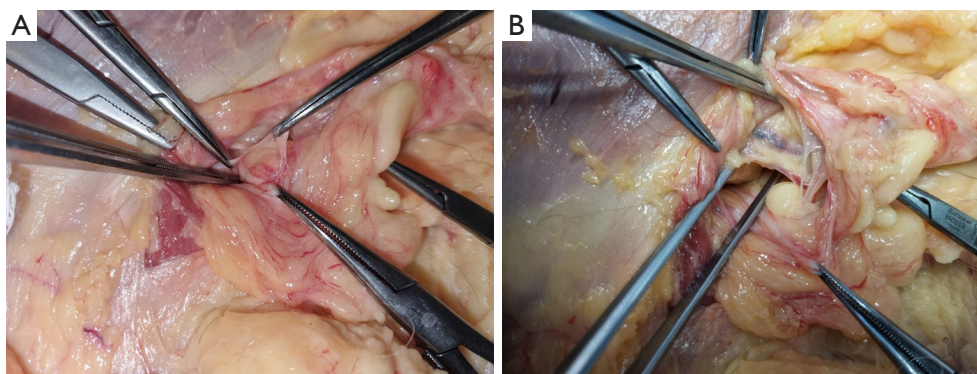


Figure 14 Cadaver dissection. (A) Transversalis fascia is open in front of the deep inguinal ring. (B) Penetration to the preperitoneal space through the deep inguinal ring.

(4.0×6.2 inches) (*Figure 3*). The dissected preperitoneal space is kept open with three retractors. One retractor lifts the anterior abdominal wall, protecting the epigastric vessels, while the other two long and narrow retractors push back the visceral bag and the bladder. To prepare the prosthesis's introduction, we use an atraumatic clamp (similar to dressing forceps) that gauges the distance between the retro-pubic region and the incision (*Figure 19A*). The prosthesis is grasped with the atraumatic forceps at its lower and median edge's middle part and introduced through the incision, parallel to the inguinal ligament, up to the retro-pubic area with consideration to the measurement made earlier (*Figure 19B*). The same forceps grasps the prosthesis's upper and lateral part and introduces it into the preperitoneal dissection area's upper and lateral parts (*Figure 19C*). The prosthesis's lower end is placed behind the pubis, and its upper end is placed near the psoas muscle. The prosthesis is thus partially deployed in the dissection space. Its deployment is completed using retractors, a finger or forceps. The prosthesis's correct position can be controlled and improved using a spatula instrument,

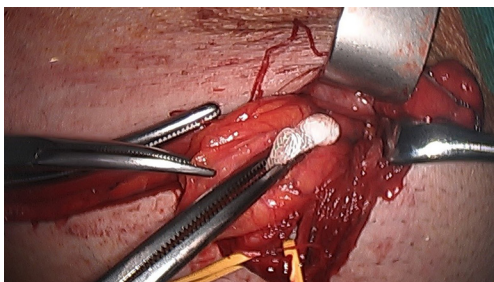


Figure 15 The dissection through the deep inguinal ring progress behind the vessels, fist with a nut.

possibly removing a fold from the prosthesis, optimizing the proper deployment of its periphery (*Figure 20*). When the prosthesis's positioning is satisfactory, the spermatic cord is reintroduced under the external oblique muscle fascia. The prosthesis is not fixed, however, it can be a discussion point for specific cases (similar to giant hernias with weakened tissues due to corticosteroid therapy, radiotherapy, etc.). With the prosthesis in place, the surgeon notices the deep inguinal ring partially closes spontaneously, “like a sphincter.” It's usually unnecessary to suture the musculo-fascial plane. Exceptionally, in the case of a large hernia, suturing the TF with a slowly absorbable suture might be beneficial to close the deep inguinal orifice around the spermatic cord. In a massive medial hernia context, the excess TF can also be sutured to avoid a seroma. When closing the external oblique aponeurosis, care is taken to avoid the ilio-inguinal nerve. The subcutaneous membranous plane is closed with an absorbable 4-0 (1.5) thread non-interrupted suture. Two reversing stitches with the same thread close the superficial adipose plane, and adhesive strips are applied to the skin (*Figure 21*). An adhesive bandage protects the adhesive strips.

Results

Missing data, loss of follow-up

For pre, per and immediate postoperative data, the loss was negligible. Given our follow-up policy and patient education, the rate of loss to follow-up remains low. However, after five failed contact attempts at different times on different days (by the CRA), patients were considered lost to follow-up. Those who declined participation in the clinical control or telephone interview were recorded

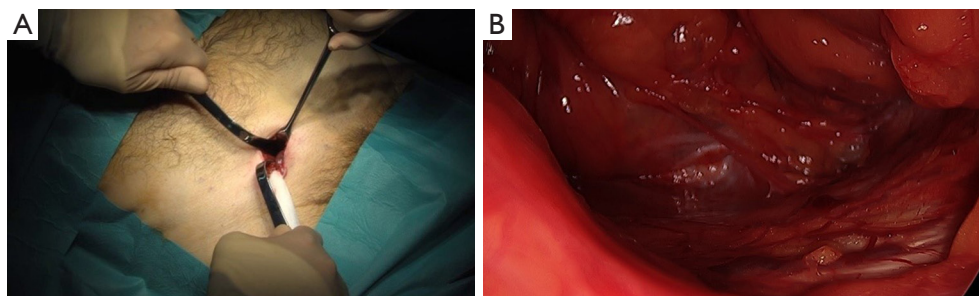


Figure 16 Dissection of the preperitoneal space at the level of the Retzius and Bogros spaces. (A) dissection extends deep down and medially with the specific dissectors according to Ugahary's principles. (B) The spaces of Bogros and Retzius the ligament of Cooper and the retro-pubic space are open and exposed, the bladder pushed back.

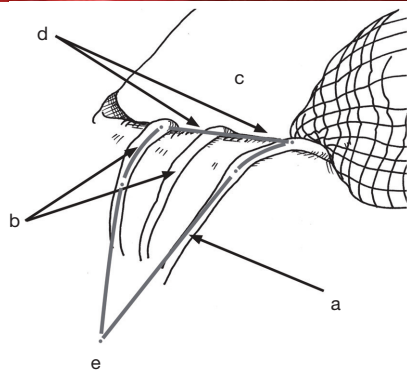
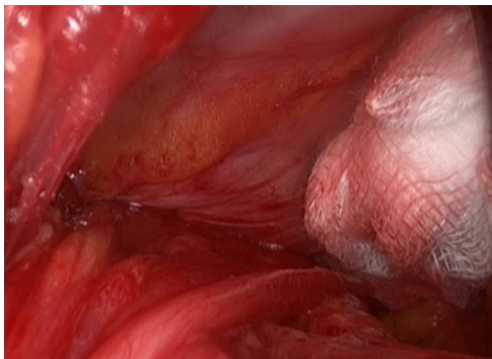


Figure 17 Parietalization of the cord visualization of the parietalization triangle. a, vas deferent; b, spermatic vessels; c, peritoneum and visceral sac; d, line of reflection of the peritoneum; e, triangle of parietalization.



Figure 18 Cadaver dissection, the internal spermatic fascia (transversalis fascia) between two clamps.

separately as potential negative outcomes. Results pertain to primary hernias operated on during scheduled surgeries using the MOPP technique and with a minimal one-year outcome from September 2011 to 29 April 2019, after

excluding previously mentioned contraindications.

Demographics, pain status at baseline and per operative data are detailed in Table 1

Total patients: 1,401 (no missing data)—male: 1,258 (89.80%), female: 143 (10.20%). Average age: 68.33 years (± 14.22), average BMI: 24.54 kg/m² (± 2.8), ASA I: 579 (41.33%), ASA II & III: 822 (58.67%). VAS: 60.97% of hernias registered a VAS score between 1 to 10, while 39% of hernias were asymptomatic. VRS: 25.63% were asymptomatic, 74.37% reported some pain or discomfort. Groin hernia location (missing data: 4)—lateral: 893 (63.9%), medial: 517 (37%), femoral (total): 53 (3.80%), or combined.

About 60% used large mesh (4.0" \times 6.2"), 40% used medium mesh (3.4" \times 5.6"). Mesh fixation was not employed. Average operative time: 40.17 \pm 14.1 minutes.

Hospital stays, postoperative course, and early outcomes (up to day 30) are detailed in Table 2

Out of 1,401 patients (no missing data): 93.93% were outpatients; No significant post-operative complications with only Dindo-Clavien grades I and II noted; no reoperations; a very low level of post-operative pain at day 30 with a VAS score of [0–3] in 95.68% of cases; severe pain was noted in 0.72% of cases.

At 3 months (chronic pain): *Table 2*. Of the 331 patients with a VAS score greater than 0 at 1 month, 181 were seen at 3 months. Their average VAS score was 0.862 \pm 1.73. The average VAS score of the 56 patients still symptomatic at 3 months was 2.754 \pm 1.84. Among these, 20 reported symptoms more severe than their pre-operative condition, while 36 reported milder symptoms. Thus, the rate of identified chronic pain in this study is 1.43% (20 out of 1,401).

Follow-up and late outcomes are detailed in Table 3

Of the 1,239 hernias reviewed with a minimum of 365 days of follow-up, 162 (11.56%) were lost to follow-up after 365 days. The review process was conducted via phone with self-palpation during coughing (79.33%) or at a medical office (20.66%). Results: out of the 1,239 hernias, 5 reinterventions were needed for 4 patients (0.36%), with a total recurrence rate of 2 patients (0.14%). No cases of

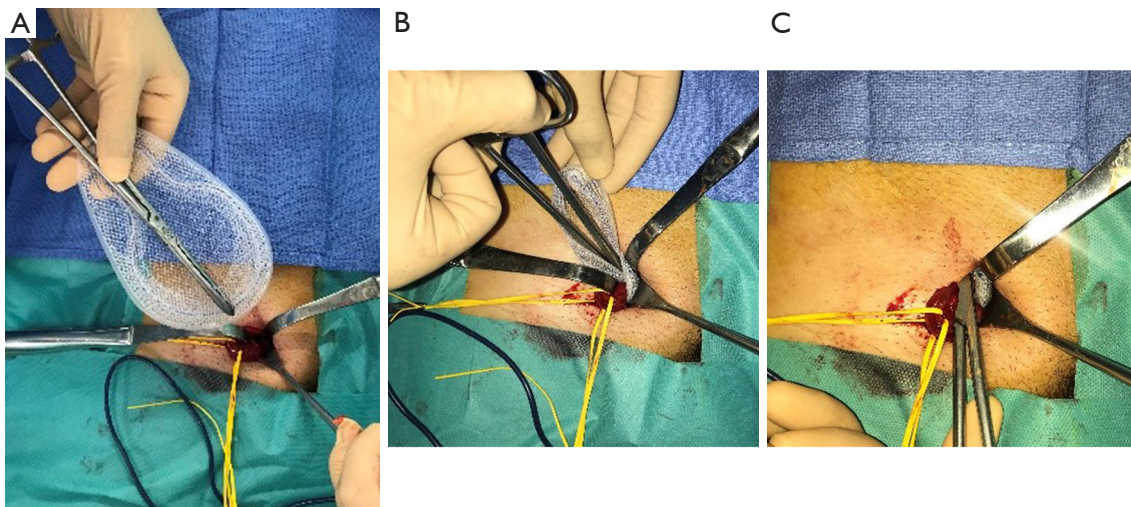


Figure 19 Introduction of the mesh. (A) The prosthesis is grasped with the atraumatic forceps at its lower and median edge's middle part. (B) The prosthesis is introduced parallel to the inguinal ligament, up to the retropubic area. (C) The prosthesis's upper and lateral part is introduced into the preperitoneal dissection area's upper and lateral parts.



Figure 20 Control of the position of the prosthesis.

testicular atrophy or intraperitoneal complications were noted.

Symptomatic patients, PROM are detailed in Table 4

Using the PROMs procedure, patients answered questions as detailed in *Table 4*. Out of 1,401 patients, 196 had missing data (13.99%). The results demonstrate the patients' overall positive perception: 99.67% felt the wall was solid, 0.66% noticed a bulge, and 6.97% reported some pain or local discomfort with none experiencing severe pain. These symptoms were less bothersome than the hernia for 84 cases and more bothersome for 6 cases. Overall, 99% of the patients rated their experience as excellent or good.



Figure 21 Strips on a 3 cm incision.

Discussion

Regarding the technique, modifications to the TIPP technique have enabled the use of a larger prosthesis in most cases, measuring 10.2 cm × 15.7 cm, through a small incision. These technical adjustments, based on identifying the fascia transversalis at two levels as previously described,

Table 1 Demographics, pain status at baseline, and per-operative data (1,401 cases in 1,146 patients)

Technique minimal open preperitoneal	Data, n (%) or mean \pm SD
Cases	1,401 (100.0)
Males/females	1,258 (89.80)/ 143 (10.20)
Age (years)	68.33 \pm 14.22
BMI (kg/m ²)	24.54 \pm 2.8
American Society of Anesthesiologists classification	
Missing data	0
ASA 1	579 (41.33)
ASA 2–3	822 (58.67)
Emergency surgery	0
Preoperative pain status (baseline)	
Preoperative Visual Analog Scale missing data	445 (31.76) ^a
VAS, N=956	2.772 \pm 2.65
VAS median for patient VAS >0	3.922 \pm 2.65
VAS 0	373 (39.0)
VAS 1–3	292 (30.54)
VAS 4–6	184 (19.24)
VAS 7–10	107 (11.19)
Verbal rating scale	
Missing data	0
No pain (asymptomatic)	359 (25.63)
Any pain or discomfort	1,042 (74.37)
Mild pain (discomfort)	423 (40.59)
Moderate pain	356 (34.16)
Severe pain	259 (24.85)
‘Uncommon’ pain	4 (0.38)
Groin hernia location	
Missing data	4 (0.28)
Lateral	893 (63.9)
Medial	517 (37.0)
Lateral + medial	44 (3.15)
Femoral total	53 (3.80)
Femoral only	32 (2.29)
Femoral + lateral	19 (1.36)
Femoral + medial	2 (0.14)

Table 1 (continued)**Table 1** (continued)

Technique minimal open preperitoneal	Data, n (%) or mean \pm SD
Mesh size	
Missing data	1 (0.07)
ASPIDE M.O.P.P. (SURGIMESH®1)-U80914p medium (9 cm \times 14 cm)	506 (36.14)
ASPIDE M.O.P.P. (SURGIMESH®1)-U81116p large (11 cm \times 16 cm)	396 (28.28)
BARD-Polysoft 0130030 medium (7.5 cm \times 14 cm)	5 (0.35)
BARD-Polysoft 0130040 large (9.5 cm \times 16 cm)	37 (2.64)
BARD-Onflex 0115410 medium (8.6 cm \times 14.2 cm)	48 (3.42)
BARD-Onflex 0115411 large (10.2 cm \times 15.7 cm)	408 (29.14)
Total medium	559 (39.90)
Total large	841 (60.10)
Mesh fixation	
Missing data	1 (0.07)
No fixation	1,400 (99.93)
Operating time (minutes)	40.17 \pm 14.1

^a, preoperative VAS was not searched for previous patients. VAS, Visual Analog Scale.

have standardized critical steps of the procedure, making them more straightforward. This standardization facilitates teaching, as evidenced by the positive outcomes presented. However, the reproducibility of this technique remains to be proven. While we might be optimistic based on the outcomes of analogous techniques like TIPP and TREPP as supported by cited studies, we cannot overlook the challenges posed by the learning curve. Merola *et al.* (29) suggest that a surgical residency’s learning curve starts around 40 hernia repairs using the Lichtenstein method. This concept is extensively discussed in “International guidelines for groin hernia” by The HerniaSurge Group (23), where they mention: a learning curve of 300 cases at the Shouldice Institute for the “Shouldice” technique. A longer learning curve for laparoendoscopic hernia repair, especially TEP, than for the open Lichtenstein method, ranging between 50 and 100 procedures. TAPP has a shorter learning curve than TEP. From my experience, the learning curve mainly results in extended procedure

Table 2 Hospital stay, postoperative course and early outcomes (up to D30)

MOPP technique	Data, n (%) or mean \pm SD
Postoperative course	
Studied cases	1,401 (100.0)
Postoperative pain VAS 0–10	
Missing data, D1; D8	445 (31.76); 31 (2.21)
Median at D1; D8	2.772 \pm 2.65; 1.543 \pm 1.75
Postoperative complications (< D30), N=77	
Missing data	5 (0.35)
General	20 (1.43) ^a
Surgical site occurrence	57 (4.08) ^b
Deep infection (peri-prosthetic)	0
Death	0
Reoperation	0
Including mesh removal	0
Dindo-Clavien classification	
I–II	77 (5.51)
IIIb	0
IV	0
V	0
Hospital stays	
Missing data	0
Outpatients	1,316 (93.93)
Inpatients	85 (6.06)
D-case not proposed	62 (4.42)
D-case proposed but failed	23 (1.64)
Hospital stays for inpatients (days)	1.57 \pm 2.04 ^c
Follow up at D30	
Missing data	173 (12.34)
Studied cases	1,228 (87.65)
Median VAS 0–10 at D30	0.587 \pm 1.2
VAS	
Median VAS for patient VAS >0	2.30 \pm 1.58
VAS 0	915 (74.51)
VAS 1–3	260 (21.17)
VAS 4–6	43 (3.50)
VAS 7–10	10 (0.81)

Table 2 (continued)**Table 2** (continued)

MOPP technique	Data, n (%) or mean \pm SD
Symptom at 1 month, N=1,250	
Missing data	151 (10.78)
No pain (asymptomatic)	919 (73.52)
Any pain or discomfort	331 (26.48)
Mild pain (discomfort)	301 (24.08)
Moderate pain	21 (1.68)
Severe pain	9 (0.72)
Symptom at 3 months	
Patients seen again at 3 months	181 (12.92)
Average VAS	0.862 \pm 1.73
Average VAS for patients symptomatic	2.754 \pm 1.84
Patients still symptomatic	56 (4.0)
More symptoms than pre-operative condition	20 (1.43)
Less symptoms than pre-operative condition	36 (2.57)
Chronic pain	20 (1.43)

^a, injection site phlebitis (n=1), phlebitis (n=2), hypoesthesia (n=8), urinary retention (n=5), other minor (n=4); ^b, subcutaneous seromas or hematomas healing spontaneously (n=50), infected superficial infection (n=2), not infected deep hematomas (n=5); ^c, one patient presented a decompensation of a Parkinson's disease, hospitalization in a medical service during 16 days. D, day; MOPP, minimal open preperitoneal; VAS, Visual Analog Scale.

durations, not necessarily inferior initial results. Given the remarkably low rates of complications, chronic pain, and recurrences, this assumption seems plausible, but it does warrant specific investigation. For novice surgeons, during the initial learning phase, I recommend starting with an incision similar in size to the one used for the Lichtenstein technique (approximately 6 cm). This approach simplifies the dissection of anatomical planes, including the cord's parietalization. Over time, they can then progressively decrease the incision size and operation duration. Currently, I cannot specify the number of procedures required to surpass the learning curve, but observations of surgeons undergoing training should be able to provide an accurate gauge over time. While this article meticulously defines the MOPP technique and its outcomes, it is currently not

Table 3 Follow-up and late outcomes (N=1,401)

Minimal open preperitoneal	Data, n (%) or mean \pm SD
Lost to follow-up	162 (11.56)
Mean follow-up (days)	1,236 \pm 603
Follow-up \geq 1 year	1,239 (88.43)
Phone questionnaire completed	983 (79.33)
Clinical visit	256 (20.66)
Identified recurrence	1 (0.08)
Late complications	
Testicular atrophy	0
Late superficial infection operated	1 (0.08)
Late sepsis or chronic sinus operated twice (no recurrence)	1 (0.08)
In another center: abscessed sigmoid diverticulosis, prosthesis removal	1 (0.08)
In another center: meshoma, prosthesis removal, recurrence reoperated	1 (0.08)
Bowel obstruction or erosion	0
Total reintervention for four patients	5 (0.36)
Total of recurrences	2 (0.14)

feasible to compare it directly with other methods due to the lack of comparative studies. However, drawing parallels to other preperitoneal techniques suggests that MOPP's outcomes might align with other open or endoscopic methods such as TREPP, TEP, and TAPP. Hurel and colleagues (15) support this assumption in their conclusion from a recent propensity score matching analysis comparing 1-year postoperative chronic pain using Lichtenstein, TIPP, TAPP, and TEP techniques. Their findings highlight Lichtenstein's clear disadvantage and an indistinguishable difference between TIPP, TAPP, and TEP.

To further explore the potential advantages of the open preperitoneal approach, including MOPP, consider these studies: Reinhorn and colleagues (13) emphasize the potential benefits of open posterior mesh placement (TREPP) over endoscopic repair in terms of short-term QOL and seroma formation, with equivalent hernia recurrence rates. Agarwal *et al.* (14) show the advantages of

Table 4 Patient-related outcomes measure

MOPP technique (minimal outcome: 24 months)	Data, n (%)
Q1. Since your operation does your abdominal wall seem:	
Missing data	194 (13.84)
Solid	1,203 (99.67)
Not solid	4 (0.33)
Q2. Do you have a new hernia or bulge in the operated groin?	
Missing data	193 (13.77)
No	1,200 (99.34)
Yes	8 (0.66)
Q3. Do you currently feel any pain or local discomfort?	
Missing data	196 (13.99)
No (asymptomatic)	1,121 (93.02)
Yes	84 (6.97)
Mild pain or discomfort	58 (4.81)
Moderate pain	26 (2.158)
Severe pain	0
Q4. These symptoms	N=84
Missing data	0
Do not interfere with your daily life	75 (6.224)
Allow to pursue the ongoing activity	6 (0.497)
Cause a temporary interruption of your activity	2 (0.165)
Prevent certain activities (impairment)	1 (0.082)
Q5. These symptoms are	
Missing data	1 (1.19)
Less bothersome than the hernia	77 (6.4)
More bothersome than the hernia	6 ^a (0.50)
Yes (please specify)	0
Q6. How do you assess the result of your hernia operation	
Missing data	205 (14.63)
Excellent or good	1,185 (99.08)
Medium	10 (0.836)
Bad	1 ^b (0.08)

^a, in these cases the result is judged by the patient: excellent [2], good [3], bad [1]; ^b, superficial infection operated with a good result, having caused temporary pain prohibiting certain activities but completely resolving. MOPP, minimal open preperitoneal.

TREPP/OPP over Lichtenstein regarding patient-reported QoL, sustained for a year, and reduced opioid consumption 30 days post-surgery. Zwols (16) and Koning (18) also highlight the superiority of preperitoneal techniques over the Lichtenstein method. Conversely, Posthuma and colleagues (17) argue that TEP offers better outcomes than TIPP, resulting in reduced postoperative pain and wound complications, even though recurrence rates and reoperations are comparable between the two. But no significant differences in QOL, reoperations, recurrence rate, and readmission within 30 days were observed. To validate the hypothesis that MOPP should yield results analogous to other open preperitoneal (TREPP) or endoscopic (TEP, TAPP) methods, I plan to conduct a study comparing MOPP to TIPP using a propensity test on a vast patient pool. Similarly, another study will compare MOPP with the TREPP technique.

Limitations concerning the technique

The author has specifically devoted his activity to being a groin hernia surgeon using the preperitoneal route for 30 years. This makes it easier for him to approach this particular type of intervention compared to surgeons who do not have experience with the open preperitoneal route. However, the author has focused his entire surgical approach on making the MOPP technique reproducible. This approach faces the reactions of surgeons in training or those already experienced who come to learn the technique in the operating room. If the technique, as practiced by the author, uses specific instrumentation, it can be replaced by basic instruments used in general surgery. Regarding the MOPP technique, the primary weak point is identical to that of the TIPP technique. The MOPP approach is not a purely posterior approach, unlike the Ugahary technique, the TREPP technique, or endoscopic techniques. Therefore, there is an anterior dissection through the inguinal canal before entering the preperitoneal space, which by definition is completely dissected. The anterior and posterior spaces are heavily remodeled during the same procedure. But this theoretically significant disadvantage is counterbalanced by the fact that recurrences are very rare. Reoperations after MOPP recurrence are difficult and time-consuming. For the patients in this study, the two recurrences were treated using the Lichtenstein technique, without complications, and with very good results after more than a year of follow-up. In the period following this study, two new recurrences were also reoperated on under

challenging anterior dissection conditions (by Lichtenstein), but also with good results. For recurrent hernias previously operated on via an anterior approach (no mesh or Lichtenstein), I use the Ugahary technique because it is a purely posterior approach, like TREPP and the endoscopic technique TEP. I had introduced the Ugahary technique in France in 2005 and used it for all primary groin hernias with good results. It was, however, challenging to teach the technique and it didn't seem reproducible enough. This was most likely because of the preperitoneal approach, which was not known to most surgeons at that time and because of the absence of specifically dedicated prostheses. This is the justification for the creation of the MOPP technique.

Limitations in relation to the prosthetic material

As shown in this study, it is preferable to use a specific prosthesis that is easy to introduce and unroll through the small incision. This prosthesis must not be too flexible and should have a peripheral reinforcement or even a hem to facilitate its unrolling and control its positioning. The prostheses used by the endoscopic route are generally very difficult to unroll anteriorly or require specific technical resources. One of the goals of the technique is to make a small incision (minimal access); which can be a difficulty during learning. It is then possible for beginners to make an incision as in the Lichtenstein technique and to reduce it with experience.

Limitations regarding the data and the results

This is a monocentric study with a single operator particularly invested in groin hernia surgery. The results could differ in the population of general surgeons. Nevertheless, these data have strong internal validity because they were prospectively collected, and all consecutive patients were registered with a high follow-up rate.

Teaching and development of the technique

Several parameters precisely developed in our study make it possible to propose the diffusion of this technique. Firstly, notions of surgical anatomy concerning the TF can help, and cadaveric dissections can be beneficial. Secondly, the use of prosthetic material dedicated to the procedure. Thirdly, we have benefited for several years from feedback from experienced and young colleagues who have participated in workshops with us. Thus, after a constant evolution of the

technique during the first years after its conception, it is now mature. The technique can be offered to experienced or novice surgeons within the framework of adequate teaching.

Conclusions

The MOPP technique offers minimal access and is minimally invasive. It is a variant of the TIPP technique, utilizing simple yet specifically dedicated instrumentation (*Figure 1*). The primary principles involve unrolling a large prosthesis in the preperitoneal space. This sutureless and tension-free technique requires a small (3–4 cm) incision near the deep inguinal ring (*Figure 2*). A thorough understanding of the surgical anatomy, particularly the TF, facilitates and optimizes the key steps of the MOPP technique. All primary groin hernias in adults can be addressed with this method. Fragile or elderly patients fall within the standard indications, with procedures typically performed as outpatient. Both the recurrence rate and the level of chronic pain observed are very low. The objective of this work is to introduce a new open preperitoneal technique that is more straightforward to teach and, consequently, more reproducible. This assertion remains to be validated by other practitioners.

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Footnote

Reporting Checklist: The author has completed the STROBE reporting checklist. Available at <https://ales.amegroups.com/article/view/10.21037/ales-23-37/rc>

Data Sharing Statement: Available at <https://ales.amegroups.com/article/view/10.21037/ales-23-37/dss>

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Conflicts of Interest: The author has completed the ICMJE uniform disclosure form (available at <https://ales.amegroups.com/article/view/10.21037/ales-23-37/coif>).

The author has no conflicts of interest to declare.

Ethical Statement: The author is accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). As this study is a monocenter, monopoperator observational retrospective study, embedded in a registry which complies with the General Data Protection Regulation (GDPR) and the French “Commission Nationale de l’Informatique et des Libertés” (National Commission for Information Technology and Liberties) CNIL (MR0003) requirements, IRB approval is not required. Informed consent was taken from all the participants.

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