



EDITORIAL

Ten golden rules for a safe MIS inguinal hernia repair using a new anatomical concept as a guide

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Abstract

Background Although laparoscopic inguinal hernia repair was described about 30 years ago and advantages of the technique have been demonstrated, the utilization of this approach has not been what we would expect. Some reasons may be the need for surgeons to understand the posterior anatomy of the groin from a new vantage point, as well as to acquire advanced laparoscopic skills. Recently, however, the introduction of a robotic approach has dramatically increased the adoption of minimally invasive techniques for inguinal hernia repair.

Methods Important recent contributions to this evolution have been the establishment of a new concept known as the critical view of the Myopectineal Orifice (MPO) and the description of a new way of understanding the posterior view of the anatomy of the groin (inverted Y and the five triangles). In this paper, we describe 10 rules for a safe MIS inguinal hernia repair (TAPP, TEP, ETEP, RTAPP) that combines these two new concepts in a unique way.

Conclusions As the critical view of safety has made laparoscopic cholecystectomy safer, we feel that following our ten rules based on understanding the anatomy of the posterior groin as defined by zones and essential triangles and the technical steps to achieve the critical view of the MPO will foster the goal of safe MIS hernia repair, no matter which minimally invasive technique is employed.

Keywords Inguinal hernia · Minimally invasive surgery · Laparoscopy · Robotic · Critical view · Golden rules

Although laparoscopic inguinal hernia repair was first introduced over 27 years ago as an alternative to conventional open inguinal hernia repairs, the majority of hernias worldwide are still repaired with an open anterior approach [1, 2]. Despite multiple peer-reviewed studies demonstrating that the approach is associated with postoperative benefits and can be safely duplicated by surgeons around the world, the growth of the technique has remained flat until very recently

[3, 4]. Even though national societies including the American Hernia Society, European Hernia Society, and the Society of American Gastrointestinal and Endoscopic Surgeons have endorsed the technique, its popularity has not grown like other laparoscopic procedures [5–7]. One has to ask why so many surgeons have failed to adopt laparoscopic inguinal hernia repair as their procedure of choice.

Recently minimally invasive surgery (MIS) for inguinal hernia repair has become the procedure of choice for surgeons that previously favored an open anterior approach [8]. They are utilizing a robotic transabdominal pre-peritoneal approach (TAPP) instead of a pure laparoscopic approach [9, 10]. The fact that so many surgeons are adopting a robotic approach over a conventional laparoscopic one gives us some insight into why the growth of laparoscopic inguinal hernia repair has been so slow. Previously surgeons had to learn the anatomy of the posterior approach and the details of the repair as well as had to master the laparoscopic skills required to safely complete the repair. For many surgeons the robotic platform has made this much easier and has initiated the recent rapid growth in MIS inguinal hernia repair [8–10].

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One of the major contributions to the evolution of laparoscopic cholecystectomy was the establishment and dissemination of the concept known as critical view of safety in order to reduce the incidence of biliary tract injuries [11, 12]. A similar concept was recently introduced for inguinal repairs by Daes and Felix [13]. The observation that some robotic surgeons tended to stray away from the basic principles that had previously been established for laparoscopic repairs, prompted Daes and Felix to publish a stepwise guide to achieving what has been called the critical view of the Myopectineal orifice (MPO). In the hope of maintaining the safety and efficacy of the MIS approach to inguinal hernia repair, their guide has standardized the dissection and posterior repair of the posterior inguinal hernia.

Crucial to a proper posterior approach, however, is understanding the anatomy. A recent publication by Furtado et al. has developed a new way to understand this sometimes confusing posterior view of the anatomy of the groin [14]. With the identification of basic anatomical landmarks and triangular areas, it becomes possible to easily define the essential zones of dissection. Combining the stepwise guide of Daes and Felix with this new anatomical approach should help those choosing an MIS approach to perform it safely and efficaciously replicating the results that previously have been published with laparoscopic inguinal hernia repair.

Discussion

In order to apply the proper steps of an MIS inguinal hernia repair, a surgeon must understand the anatomy of Myopectineal Orifice. By using the inverted Y concept and the 5 triangles published by Furtado et al. [14] (Fig. 1), the anatomical landmarks of dissection are defined and should provide a roadmap for a safe and proper MIS inguinal hernia repair, following the critical view and surgical steps published by Daes and Felix [13]. To further aid in

understanding the proper steps of an MIS inguinal hernia repair, the areas of dissection are sub divided into three zones and 10 rules. In summary, three zones established are: *Zone 1*: corresponds to the lateral area to deep inguinal ring and spermatic vessels; *Zone 2*: is medial to inferior epigastric vessels and vas deferens and corresponds to the site of direct hernias; *Zone 3*: represents the operative area that demands more attention which includes inferior epigastric vessel and deep inguinal ring superiorly and spermatic cord elements and external iliac vessels (Fig. 2). Following we described detailed the 10 rules we considered essential to proper and safe inguinal MIS repair.

Rule 1: Beginning of surgery

In TAPP, incision of the peritoneum should be at least 4 cm above the deep inguinal ring border to allow the placement of a large prosthesis in the pre-peritoneal space. The opening flap should extend from the anterior–superior iliac spine (ASIS) to the medial umbilical fold (equivalent to obliterated umbilical artery).

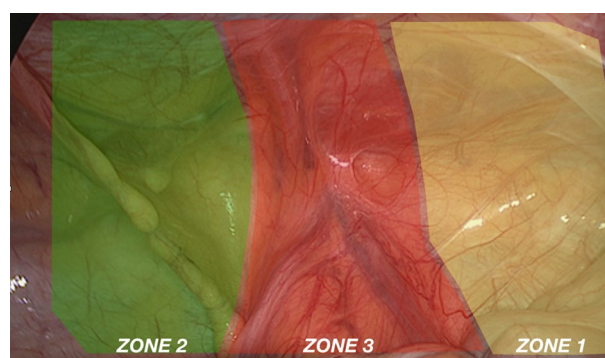


Fig. 2 (Right groin) Three zones of dissection of pre-peritoneal space following the tactical proposal for standardization of MIS techniques

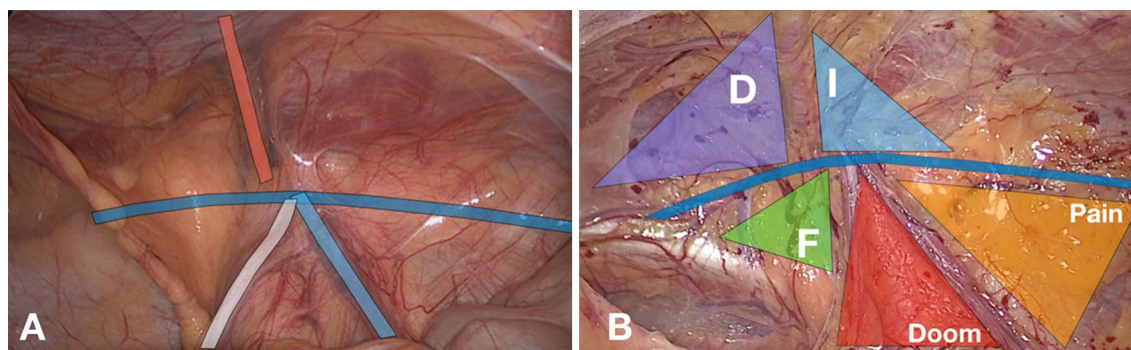


Fig. 1 (Right groin) **A** Y inverted: inferior epigastric vessels (red—superiorly), vas deferens (white—medially), and spermatic vessels laterally (blue—laterally); **B** Iliopubic tract (represented in dark blue)

that passes horizontally through the deep inguinal ring at the center of the inverted Y and it enable visualization of five areas in MPO known as the “Five Triangles” (Color figure online)

In TEP, dissection of the initial space with direct use of the telescope (blunt dissection) or balloon trocar appear to be equally effective. While the telescopic direct access is associated with lower costs, the use of trocar balloon seems to facilitate the creation of initial space, specially during initial experience and decrease operative time.

Rule 2: Dissection should follow the peritoneal plane

Fatty tissue present in the pre-peritoneal space should be kept in contact with the inguinal floor and not with the peritoneum. The plane that exposes the muscle should be avoided in order to prevent damage of inferior epigastric vessels at Zone 3 or injury of nerves at Zone 1 (Fig. 3). The nerves should not be systematically dissected or identified as is recommended in open repairs. This may reduce exposure of those nerves to the foreign body reaction induced by the mesh integration and may reduce the incidence of postoperative chronic pain.

Comment: In TAPP we recommend starting the dissection either by Zone 1 or Zone 2 according to surgeon preference leaving Zone 3 for last. The medial zone has the most constant anatomy and identifying the pubis helps orient the surgeon. In TEP, Zone 2 dissection is usually done initially (either with balloon trocar or by blunt dissection with the telescope), followed by Zone 1 and Zone 3, respectively. Dissection of Zone 3 or the central zone is left for last because it is usually the most difficult step and can have the most variable anatomy. Injuries to the vas or vessels as well as tears in the peritoneum can occur during this step in the dissection.

Rule 3: Dissection should extend to at least the pubic symphysis and at least 2 cm below the pubis at Zone 2, in order to create sufficient space to accommodate an adequately sized mesh, that overlaps Direct and Femoral Triangles by at least 3–4 cm (Fig. 4) and will not be lifted by the distending bladder.

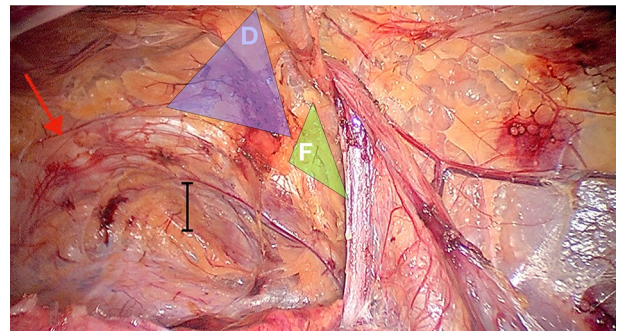


Fig. 4 (Right groin) Dissection of Zone 2 extends to at least until the pubic symphysis (marked by the red arrow) and 1–2 cm below the pube (black marker). The femoral (green) and direct (purple) triangles are didactically illustrated (Color figure online)

If present, the direct hernia is dissected, and the hernia's contents are reduced but the attenuated fascia transversalis is dissected and kept distally. When dissecting the direct hernia the surgeon must remain in the correct plain in order to avoid injuring the bladder if it is part of the hernia.

Comment: The bladder should be emptied before the operation is begun. A full bladder may decrease the operative field and make it difficult to dissect Zone 2. In addition, a distended bladder may push or fold the lower edge of the mesh during CO₂ deflation, which is a potential cause of recurrence. A foley catheter is not routinely recommended if the patient to empties their bladder before entering the operating room.

Comment: There is no consensus regarding suturing or plicating the transversalis fascia in cases of direct hernias. Some feel that it may reduce the risk of seroma formation, while others doubt its need and feel it may be associated with potential nerve injury. Since the introduction of robotic MIS inguinal hernia repair, this practice has become more common and the outcomes need to be further evaluated.

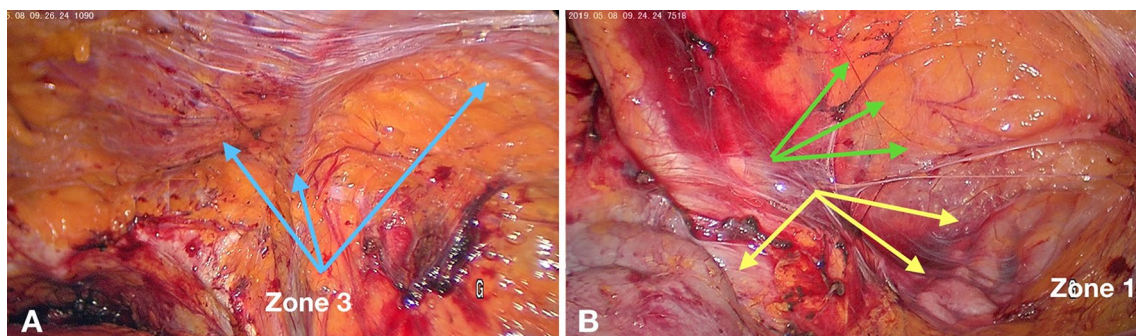


Fig. 3 (Right groin) **A** Exposed muscle plane is avoided, protecting inferior epigastric vessels at Zone 3; **B** Peritoneum represents the plane of dissection (yellow arrows) keeping fat tissue in contact with

the abdominal wall (green arrows) protecting the nerves at Zone 1 (Color figure online)

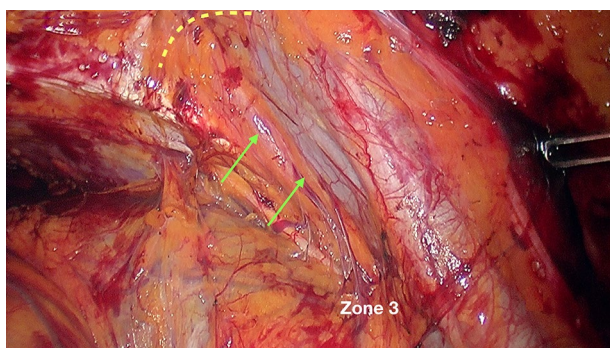


Fig. 5 (Right groin) At Zone 3, the external iliac vein (marked by the green arrow) should be visualized avoiding a missed femoral hernia through the femoral canal (represented by the yellow dotted line) (Color figure online)

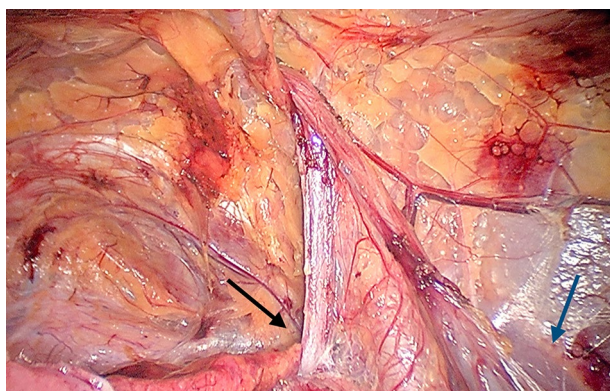


Fig. 6 (Right groin) Inferior dissection in Zones 1 and 3 should extend until the identification of the iliopsoas muscle (blue arrow) happens and the crossing of the vas deferens over the external iliac vein is reached (black arrow) (Color figure online)

Rule 4: The external iliac vein should be visible, thus avoiding a missed femoral hernia in zone 3 (Fig. 5).

Lymph nodes may be present along the external iliac vein, which must be differentiated from the pre-peritoneal fat that protrudes into the femoral canal in cases of a hernia.

Rule 5: Parietalization of the elements of the cord is considered sufficient when the peritoneum is dissected inferiorly until at least the level at which the vas deferens crosses the external iliac vein in Zone 3 and the iliopsoas muscle is identified posteriorly at Zone 1 (Fig. 6).

In Zone 3, dissection of indirect hernia sac (indirect triangle) is the most demanding step in hernia repair. During the dissection of the indirect hernia sac, peritoneum should be mobilized medially and laterally to facilitate the identification of the elements of the spermatic cord (spermatic

vessels and vas deferent), thus avoiding injury to them and external iliac vessels (triangle of doom) located just deep to the spermatic cord.

Comment: In women, round ligament of the uterus is usually closely adherent to the peritoneum. Transection of round ligament is then recommended, at least 1 cm proximal the deep ring in order avoid injury of genital branch of the genitofemoral nerve at this location.

Rule 6: In large or inguino-scrotal hernias, it is recommended to transect and abandon the distal hernia sac within the scrotum.

An indirect hernia sac is usually dissected and reduced from the inguinal canal. When dealing with large hernia sacs or chronic and fibrotic ones, one may safely transect the hernia sac only after safely identifying the elements of the spermatic cord. This decision is made to avoid excessive dissection of the cord elements thus avoiding injury to them.

It is easier to deal with a pseudo-hydrocele postoperatively than with a hematoma of the scrotum, ischemic orchitis or injury to the spermatic cord.

Rule 7: The deep inguinal canal should be explored during Zone 3 dissection in search of lipoma of the cord

The so-called cord lipoma is an extension of retroperitoneal fat that usually runs laterally to the elements of the spermatic cord at the deep inguinal ring area. Often the simple visual inspection of the deep inguinal annulus does not clearly identify the presence of a lipoma. Any lipoma must be dissected and reduced from the inguinal canal. Untreated lipomas are a major cause of recurrence after laparoscopic repair [15]. They do not require removal, but should be placed on top of the mesh to help prevent upward mesh rolling. Since lipomas if present crossover the iliopubic tract, identification of the tract is a good indicator that there is no lipoma or that it has been adequately reduced (Fig. 7).

When dissection of all 3 zones of the inguinal region is completed in either the TAPP or TEP techniques, the surgeon, will be able to recognize the elements of the MPO, (ie the inverted Y and the 5 triangles as seen in Fig. 1 and Fig. 8).

Only if all anatomical elements have been recognized, the steps of dissection described above have been completed and hemostasis achieved should the surgeon proceed with mesh placement.

Rule 8: A large mesh (usually at least 10 cm craniocaudally \times 15 cm medio-laterally) may be placed covering the MPO (Indirect, Direct and Femoral triangles) with overlap of at least 3–4 cm (Fig. 9).

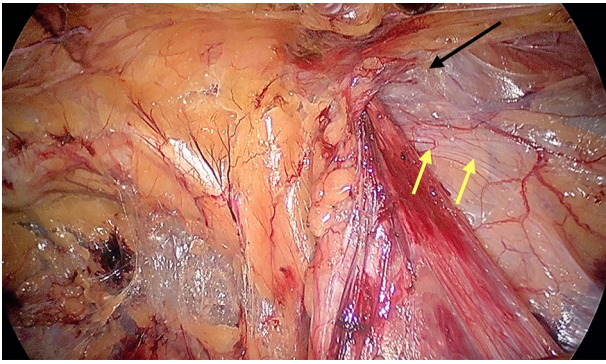


Fig. 7 (Right groin) Iliopubic tract should be identified (yellow arrows) and the deep inguinal annulus (black arrow) should contain only the elements of the spermatic cord. The presence of fatty tissue hiding the iliopubic tract and entering the deep annulus should be dissected and reduced (Color figure online)

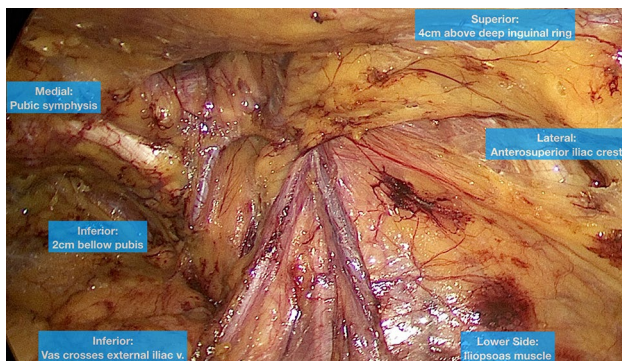


Fig. 8 (Right groin) Limits of dissection—postero-lateral: iliopsoas muscle; inferior: crossing of the vas deferens in relation to the external iliac vein and 2 cm below pubic bone; medial: pubic symphysis; superior: 4 cm above the deep inguinal annulus

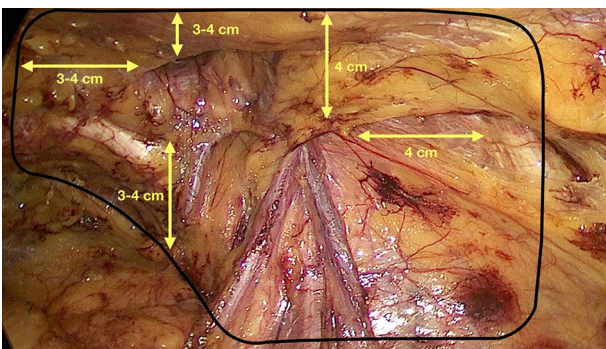


Fig. 9 (Right groin) Schematic representation of the mesh positioning covering the MPO with minimum overlap of 3 cm

Mesh should reach medially at least the pubic symphysis and laterally the ASIS and iliopsoas muscle. On direct hernia repairs, 1–2 cm of mesh crossover to the contralateral area is

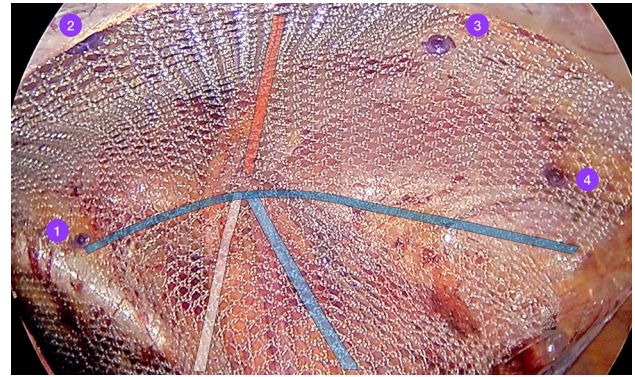


Fig. 10 (Right groin) Mesh fixation with tacks. 1. above the pubic bone; 2. medial to epigastric vessels; 3. lateral to inferior epigastric vessels, 4. Two centimeters above iliopubic tract

desired to achieve a minimum 3 cm medial overlap from the direct defect. Inferiorly it should descend 1–2 cm below the pubis and superiorly cover 3–4 cm the anterior abdominal wall in relation to the deep inguinal annulus. The surgeon must be certain that the peritoneum is not left behind the mesh in order to avoid folding and/or rolling up of it during evacuation of the gas or peritoneal closure during a TAPP. Medially the mesh should be positioned between the pubic bone and the bladder into the Retzius space and laterally it should lie next to the iliopsoas muscle. The mesh should be placed without wrinkles or folds and should not be splitted in order to avoid chronic pain or recurrence [16].

Rule 9: Mesh fixation is not necessary, especially in TEP [5].

Several types of mesh fixation are available but, in most MIS inguinal hernia repairs mesh fixation is unnecessary. Mesh fixation is recommended in large inguinal hernias, especially direct hernias (M3 according to EHS classification) [17]. If the surgeon decides for traumatic fixation with staples, tacks or sutures, the recommendations are (Fig. 10):

- avoid bone structures: tacking should be performed above the pubic bone, into the Cooper's ligament, thus avoiding the risk of chronic osteitis;
- attention to and avoidance of the inferior epigastric vessels
- traumatic fixation should not be placed below the iliopubic tract. To avoid potential injury in the triangles of pain or doom consider 2 cm above the iliopubic tract for extra safety.
- 5 to 6 fixation points are sufficient to fix the mesh (higher tack numbers are associated with increased risk of chronic pain) [18].
- a bimanual technique of palpating the abdominal wall, while placing penetrating fixation should be used to

prevent placing anchors below the iliopectic tract or too deeply.

It is important to stress that securing the mesh with tacks, sutures, glue or self-fixing mesh does not prevent problems of improper dissection or incorrect mesh positioning.

Rule 10: Deflation under direct visualization

In TEP, a grasper can be used hold the inferior edge of the mesh during CO₂ deflation (assisted deflation) in order to prevent the peritoneum folding or rolling up the bottom of the mesh. If the mesh moves as the peritoneum re-expands at the end of the TEP procedure more dissection of the pocket is required. Similarly, at the end of a TAPP as the peritoneal flap is approximated, the mesh must not be elevated by the closure. Attention should be paid to ensure that the peritoneum does not fold the bottom edge of the mesh. Suture closure of the peritoneum is recommended instead of tacking it closed because the latter technique may increase the potential for nerve injuries. Most surgeons agree that gaps, holes or tears of the peritoneum should be closed to reduce the risk of early bowel obstruction or mesh exposure.

Comment: In TAPP, after peritoneal flap closure, suction of the gas in the pre-peritoneal space has been used by some authors to simulate the effect known as "sandwich" that occurs in TEP for mesh fixation [19].

Conclusion

As the critical view of safety has made laparoscopic cholecystectomy safer, we feel that following our ten rules based on understanding the anatomy of the posterior groin as defined by zones and essential triangles and the proper technical steps to achieve the critical view of the MPO, MIS repairs (TAPP, TEP, ETEP or RTAPP) should be standardized and further safe dissemination of the technique be facilitated. Prevention is the best strategy to prevent complications and we believe that following the rules of repair outlined along with an understanding the anatomy of the region will achieve the goal of safe MIS hernia repair no matter which minimally invasive technique is employed.

Compliance with ethical standards

Disclosure Drs Claus C, Furtado M, Malcher F, Cavazzola LT, Felix E have no conflict of interest related to this paper.

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