

# Different Port Closure Techniques in Laparoscopy Surgery

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## Abstract

*Introduction:* Any new surgical procedure, face a new technical challenges, although minimally invasive surgery cause evident reduction of the pain to the patient postoperatively, with better cosmesis, but with time, new challenges appears.

One of challenges is port closure techniques, in order to prevent the trocar site hernias and other complications .

*Aims:* The aim of this study to review and list different techniques used for closure of the trocar sites.

*Methods:* A literature search was performed for articles and text books dealing with techniques of closure. The author searched this subject using Medline and the search engine Google, Springerlink and High wire Press. The following search term were used; port site closure techniques. Review, All articles reporting techniques with their references were reviewed with some text books.

*Results:* in this literature review we described many techniques in addition to classical closure using curved needles, including Grice needle, Maciol-needles, endoclose device.

Carter-Thomason device, Tahoe ligature device, Endo-Judge device, exit puncture closure device, Owsley retractor, spinal cord needles, dual hemostat, Veress needle loop technique, suture carrier, Riverdin and Deschamps needles, and Gore-Tex closure device. Semm's emergency needle with adistal eyelet; the modified Veress needle with a slit made in the retractable blunt tip; dental awl with an eye; prolene 2/0 on a straight needle aided by a Veress needle; a straight needle armed with suture; Auto stitch (United States Surgical), a modified Veress needle bearing a crochet hook at the tip. Foley catheter threaded through the port hole for the elevation of fascial edge upon traction; fish-hook needle improvised out of a hypodermic needle by bending it 180°; Grooved director; U-shaped purse-string suture placed in the fascia around the port hole .

*Conclusion:* Although there are different techniques used to close the trocar site, all of them are effective in closing the defect in the fascial layers of the abdominal wall, two main groups of techniques were found.

**Keywords:** Port closure, techniques, complication, laparoscopy surgery.

## INTRODUCTION

Around 200 years ago, endoscopy was first started with the help of tin tube at the end of which candle was placed to provide the illumination.<sup>1</sup> The modern area of laparoscopy started in 1966 with the development of Hopkin's-Rod system.<sup>2</sup> The introduction of any surgical procedure brings with it new technical challenges. Because laparoscopy offers patients a reduction in pain and better cosmesis, it is being used more frequently today. Laparoscopy allows for more intricate procedures to be performed, but larger ports are required to execute such complex surgeries.<sup>1</sup> Along with larger ports come larger abdominal incisions and thus an increase in the possibility of complications following surgery.<sup>3</sup> These complications can include incisional bowel herniation as well as small bowel obstruction.<sup>4,5</sup> The closure of laparoscopic trocar sites is helpful in reducing such complications. In 1968, Fear<sup>6,7</sup> was the first to report ventral hernia at a trocar site after laparoscopy. Trocar complications occur in approximately 1 to 6% of patients.<sup>8-16</sup> Herniation associated with laparoscopic trocar sites can occur with incisions as small as 3 mm.<sup>17</sup> It is recommended that all 10 and 12 mm trocar sites in adults and all 5 mm port sites in children

be closed, incorporating the peritoneum into the fascial closure.<sup>10,18-20</sup> Standard suture techniques can be difficult and frustrating, often involving blind closure of the fascial defect. A number of techniques and devices have been developed to facilitate this fascial closure.

## METHOD

Selected papers were screened for further references. Criteria for selection of literature were the number of cases (excluded if less than 20), methods of analysis (statical or nonstatical), operative procedure (only universally accepted procedures were selected) and the institution where the study was done (specialized institution for laparoscopic surgery). Textbooks of laparoscopic surgery also were reviewed.

## RESULTS

Port closure techniques could be classified from a technical point of view into two groups:

*1st group:* With laparoscopic visualization (Must be seen through telescope).

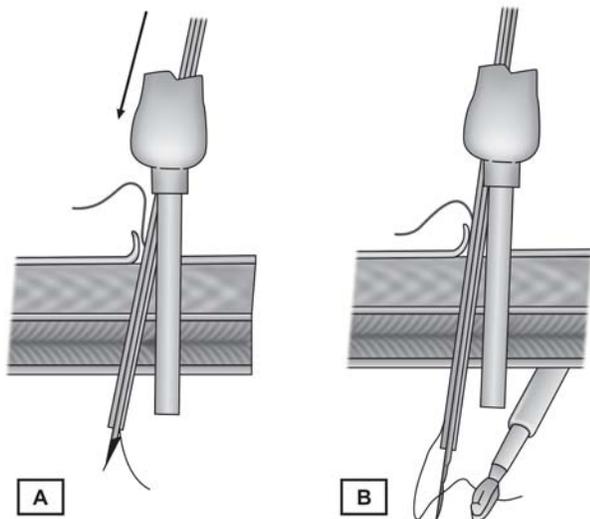
2nd group: Without laparoscopic visualization (must be seen by surgeon, no telescope).

**FIRST GROUP**

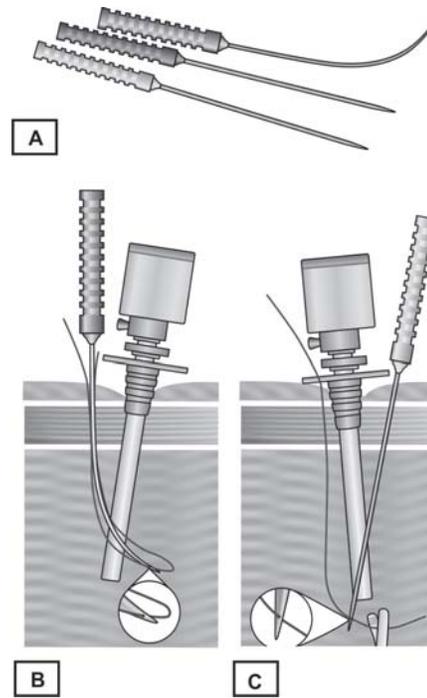
The manipulation of this group is performed from inside the abdomen under direct visualization, the maximum safety in avoiding visceral injuries. These techniques include Maciol needles, the Grice needle, catheter or spinal needles, the endoclose device, and the Gor-Tex device, Reverdin, Deschamps needles, Semm's emergency needle with a distal eyelet; the modified Veress needle with a slit made in the retractable blunt tip; dental awl with an eye; prolene 2/0 on a straight needle aided by a Veress needle; a straight needle armed with suture; Autostitch (United states surgical), a modified Veress needle bearing a crochet hook at the tip, veress needle loop technique.<sup>29</sup>

*Grice needles* Used by Stringer et al,<sup>16</sup> A Grice needle (Figs 1A and B) was inserted at an angle along the side of a lateral trocar. Under direct laparoscopic visualization, the needle was placed through both the peritoneum and the fascia. Within the abdomen, the suture was grasped and removed from the Grice needle with a grasper inserted from the opposite trocar. The Grice needle then was removed and reinserted opposite the previous puncture, again at an angle along the trocar. The suture was regrasped with the Grice needle and pulled out of the abdomen. After complete removal of the trocar, the suture was tied under direct laparoscopic visualization.

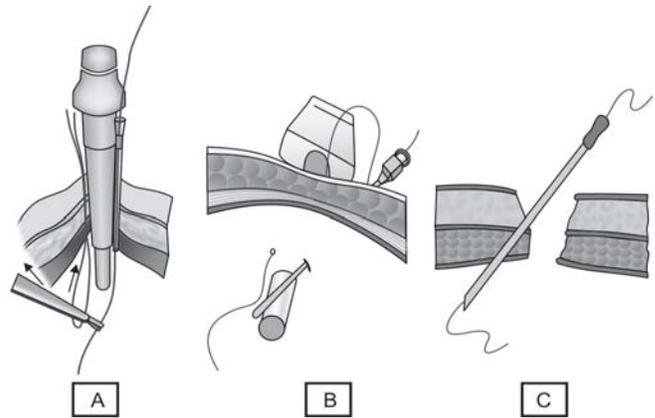
*Maciol needles.* Contarini<sup>6</sup> reported using Maciol needles (Core Dynamics, Inc. Jacksonville, FL, USA, Maciol needles (Fig. 2A) are a set of three needles: Two black handled introducers, one straight and one curved, and a golden-handle retriever. The introducer needle (needle with an eye) is used to pass the suture through the abdominal wall into the peritoneal cavity from the subcutaneous tissue (Fig. 2B). The retriever needle (needle with a barb) is next passed into the abdomen on the opposite side of the defect to retrieve the suture, then pulled



**Figs 1A and B:** Grice needle



**Figs 2A to C:** (A) Maciol suture needle set (B and C) Maciol needles



**Figs 3A to C:** Vein catheter, spinal cord needle, and angiocath needle

back through the tissue (Fig. 2C). The procedure is performed under direct laparoscopic visualization before trocar withdrawal and does not require any enlargement of the skin incision.

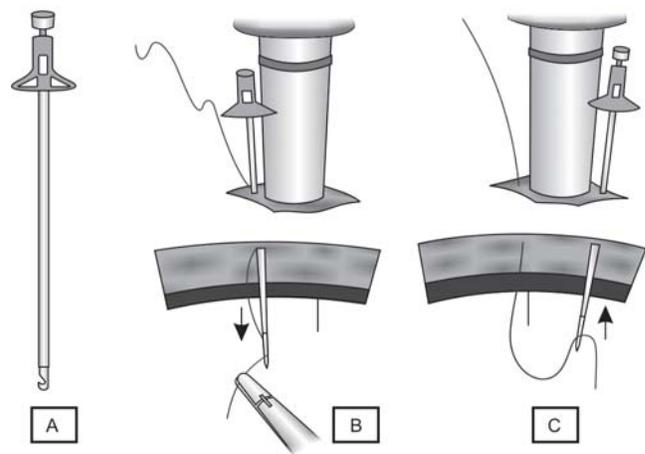
*Vein catheter, angiocath needle, and spinal cord needle.* Nadler et al.<sup>22</sup> used a venous catheter (Fig. 3A). direct laparoscopic visualization to secure the abdominal wall fascia and peritoneum, (Fig. 3B). A continuously running nonabsorbable 0-polypropylene suture is inserted through a 15 gauge needle, which penetrates all subcutaneous layers including the fascia, going around the umbilical opening at a 45 degree angle to create a purse string. The needle penetrates the fascia at a distance of 0.5 to 1 cm from the trocar site. After the first insertion of the needle, an endograsp forceps is used to pull the free suture edge into the abdomen Then the needle, still

holding the suture, is reinserted at the next point and, with the use of the forceps, the free intra-abdominal edge of the suture is locked through the loop that has been created. This maneuver is repeated another three times until the purse string is fashioned. In the final step, the suture edge, which is pulled by the last loop, and the needle are withdrawn outside the abdomen near the site of first needle insertion, and both edges of the suture are tied up onto the fascia, angiocath needle to perform the same closure technique (Fig. 3C). The large 10 mm trocar is removed, and the pneumoperitoneum is maintained in all abdominal trocar wounds 10 mm or larger simply by placement of a gloved finger over the top of the wound. A 14 gauge angiocath needle with the sheath removed is preloaded with a 50 cm length of 0- braided polyglactin suture. The angiocath and suture are inserted through all fascia layers on one side of the laparoscopic wound with laparoscopic visualization. Carefully, the needle and suture are placed in the exact middle of one side of the trocar wound. The surgeon or surgical assistant grasps the suture through a previously made 5 mm port. The needle is removed, and the suture is pulled a short distance (10-15 cm) into the abdominal cavity. A 5 mm grasping instrument is inserted directly through the subxiphoid or any large trocar wound, and the suture is grasped. The 5 mm grasping instrument and suture are removed from the abdominal cavity. The four steps are repeated by passing another preloaded angiocath needle and suture through the midpoint of the other side of the trocar wound. The suture is brought out through the same trocar hole. The ends of the suture are tied together with several square knots. The knot is reduced into the peritoneal cavity by pulling on one or both ends of the tied suture. The knot may be removed by pulling it through the fascia, thereby leaving a single strand of suture for closure of the fascia. The fascia is then closed, and the suture is tied under direct vision through the laparoscope.<sup>23</sup>

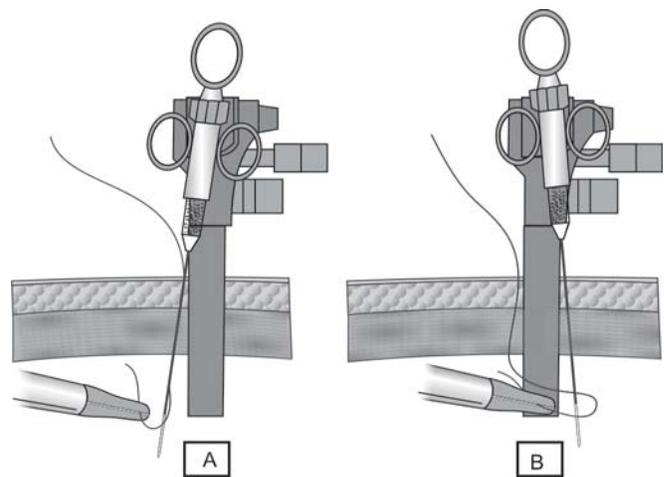
**Endoclose suture device.** This is a disposable endoclose device (Tyco Auto Suture International, Inc. Norwalk, CT, USA) with a spring-loaded suture carrier (Fig. 4A) is loaded with a 0-absorbable suture and introduced into the abdomen between the edge of the skin and the port. The suture is released and dropped in the abdominal cavity, after which the device is removed (Fig. 4B). The spring-loaded suture carrier is then passed through the fascia and peritoneum 180° degree from the original insertion site between the skin incision and the port. With the assistance of a 5 mm grasping forceps through a secondary port, the suture is reloaded onto the opened notch in the endoclose needle (Fig. 4C). The device and suture are brought out of the abdomen. The port is removed, and the suture is tied to approximate the fascia and peritoneum.<sup>23,24</sup>

### THE GORE-TEX SUTURE PASSER

Chapman<sup>25</sup> used the Gore-Tex suture passer (WL Gore and Associates, Phoenix, AZ, USA), which is a reusable trocar closure device. With the trocar still in place and the abdomen



Figs 4A to C: Endoclose suture device



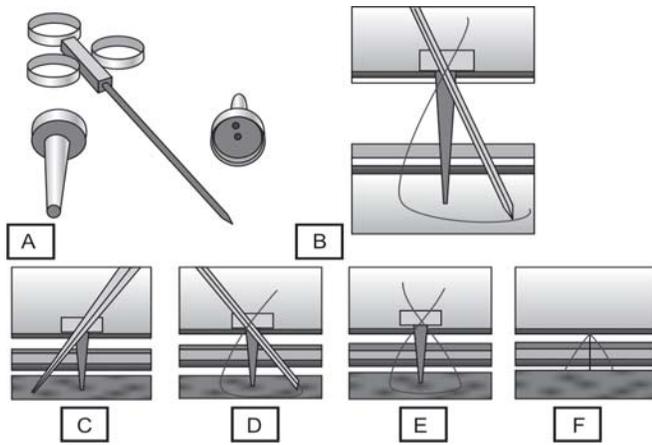
Figs 5A and B: The Gore-Tex suture passer

distended by the pneumoperitoneum, the laparoscope is used to view the trocar site to be closed. The end of the trocar should still be visible within the peritoneal cavity.

The suture is loaded into the Gore-Tex Suture Passer, then passed through the subcutaneous tissue and fascia on one side of the trocar (Fig. 5A). The suture is released from the passer by pushing down on the handle, then grasped intraperitoneally with a blunt grasper. The suture passer is then removed and inserted through the subcutaneous space and fascia on the opposite side of the trocar. The suture is placed back in the jaw of the suture passer and locked into position by pulling back on the handle (Fig. 5B). The suture is then removed by pulling the passer out. Next, the trocar may be removed and the suture tied down.

### CARTER-THOMASON DEVICE

The Carter-Thomason close-sure system (Inlet Medical, Inc., Eden Prairie, MN, USA) is of two parts (Figs 6A and B): The Pilot guide and the Carter-Thomason suture passer. Closure of the port incision requires four easy steps: (1) use the suture

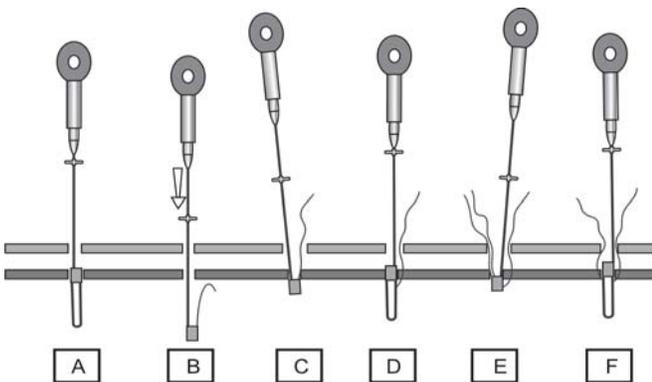


Figs 6A to F: Carter-Thomason device

passer to push suture material through the Pilot guide, fascia, muscle, and peritoneum into the abdomen, then drop the suture and remove the suture passer) (Fig. 6C), (2) push the suture passer through the opposite side of the pilot guide and pick up the suture (Fig. 6D), (3) pull the suture up through the peritoneum, muscle, fascia, and guide (Fig. 6E), and (4) remove the Pilot guide and tie (Fig. 6F). Designed specifically for bariatric and obese patients. The suture passer and Pilot guides have been lengthened to reach through the peritoneum in the larger patient to provide full-thickness closure in this at-risk group.<sup>23</sup>

**ENDO-JUDGE DEVICE**

The Endo-Judge wound closure device (Figs 7A to F), a 14 gauge hollow J-shaped needle that serves as a carrier for suture material and a device for performing the fascial closure. The suture is mounted on a reel at the proximal end of the device and fed to the hollow needle until it is delivered out the needle tip. The plastic oval shield (olive) at the J-portion of the needle maintains pneumoperitoneum and prevents injury to underlying structures. Reverdin and Deschamps needle can also be used same way to close the port (Figs 13A and B). It is controlled by a sliding ring located on the shaft of the instrument. The device should be used under direct visualization. The Endo-Judge is



Figs 7A to F: Endo-Judge device

passed into the abdomen until the olive is visible below the peritoneum. The instrument is then positioned in a plane perpendicular to the trocar incision to expose the needle and pass it through the peritoneum and fascia until it exits the skin incision. The end of the suture is grasped and tagged with a hemostat. The needle is dropped back into the olive, and the instrument is rotated 180°. The olive is again dropped to expose the needle, which is again passed through the peritoneum and fascia. After removal of the Endo-Judge, the suture is tied, creating a secure, airtight fascial and peritoneal closure.

**The 2 mm trocar technique.** Reardon et al.<sup>24</sup> A 2 mm trocar and sleeve are introduced adjacent to the port whose entry site will be closed. A monofilament heavy-gauge suture with the needle removed is passed through the lumen of the 2 mm sleeve. The 2 mm sleeve is then removed over the suture, after which the 2 mm trocar and sleeve are reintroduced through the opposing fascial edge 180° from the original insertion site. The trocar is removed, and a 2 mm grasper is passed through the sleeve and used to retrieve the intra-abdominal end of the suture.

**THE 5 mm TROCAR TECHNIQUE**

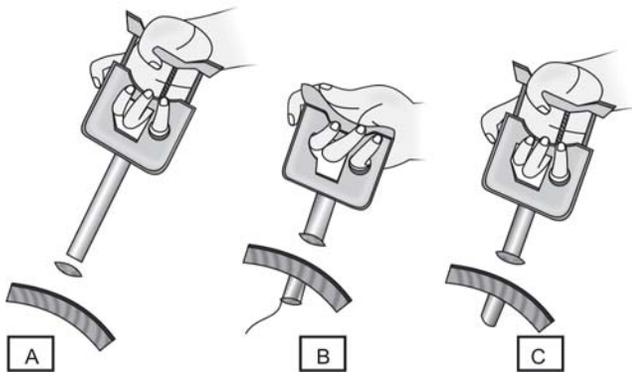
Rastogi and Dy<sup>25</sup> developed a simple technique using the regular curved needle and sutures for closure of peritoneal and rectus sheath defects at the port site. Using a 5 mm telescope, they inspect the defect from the inside, and then pass a hemostat through the incision. Under direct telescopic vision, the peritoneum and rectus sheath are grasped at both the upper and lower edges and pulled through the incision, facilitating the passage of the needle. Chatzipapaset et al.<sup>9</sup> developed a similar closure technique using standard sutures with straight needles, a 5 mm laparoscopic grasper, and a 4 mm hysteroscope.

**TAHOE SURGICAL INSTRUMENT LIGATURE DEVICE**

It is disposable. Initially, the laparoscopic cannula is removed. A 0-absorbable suture is placed into the hollow delivery Tahoe needle without extension beyond the distal end of the needle (Fig. 8A). The device is introduced into the abdomen after the needles are first inserted through the two holes on an introduction disk. The needle tips are then guided to pierce the fascia on either side of the port site. The lock is released, and the handle is depressed until the metal retrieval loop is extended and encompasses the tip and distal shaft of the delivery needle. The suture is fed into the delivery needle until it lies several inches beyond the distal end of the delivery needle and through the retrieval loop (Fig. 8B). The handle is released, allowing the retrieval loop to retract, thereby securing the suture in the closed metal loop. The entire device is withdrawn from the abdomen (Fig. 8C), thus delivering the two ends of the suture onto the abdominal wall. The suture is tied, approximating the peritoneum and fascia.<sup>24</sup>

**EXIT DISPOSABLE PUNCTURE CLOSURE DEVICE**

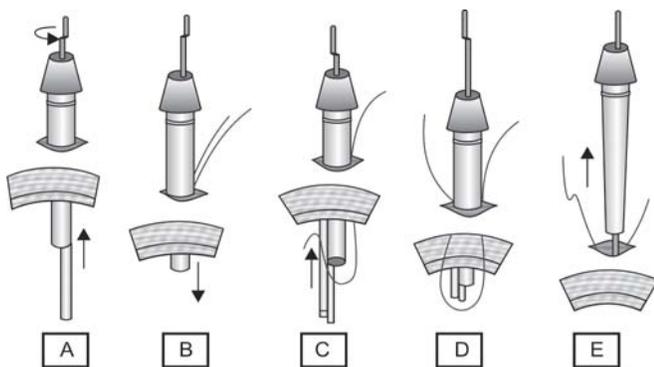
A 10 mm instrument with a recessed right-angle needle that can be exposed by rotating a dial at the top of the instrument. The



**Figs 8A to C:** Tahoe surgical instrument ligature device

device is introduced through the 12 mm laparoscopic port. When laparoscopically visualized in the abdomen, the right-angle needle assembly is rotated to the open position, thereby exposing the needle carrier (Fig. 9A). The device is then pulled back up through the port, thereby drawing the needle up through the peritoneum and fascia between the skin and the port. The skin is pulled away from the tip of the needle to avoid puncture of the skin. When the needle is seen coming through the subcutaneous fat, a 0-absorbable suture is loaded through the hole in the needle (Fig. 9B). The needle and suture, along with the entire device, are pushed back down through the port into the abdomen, thereby passing the suture down through the fascial and peritoneal layers. The exit device is then rotated 180° to the opposite side of the port (Fig. 9C), and the needle carrying the suture is again delivered through the fascia and peritoneum. The needle is identified in the subcutaneous tissue, and the suture is pulled from the tip of the needle (Fig. 9D). The device is returned back in to the abdomen; the needle is closed; and the closed device is removed through the port (Fig. 9E). The port is removed, and the suture is tied, securing the peritoneum and fascia.<sup>24</sup>

*Veress needle loop technique*; used by RK Mishra, making a loop by passing nylon suture to veress needle and tied it, then loadge the vicryl suture to the tip of veress needle, then push the veress needle with the loop, through the abdominal wall, with out piercing the skin, 3 mm away from the trocar site, then remove the veress, leaving the vicryl in side, by putting your finger on the vicryl, grasp the vicryl by grasper, and pass



**Figs 9A to E:** Exit disposable puncture closure device

it to the other side of the trocar, to push it in side the veress loop, after piercing the abdominal wall, leaving the skin, and then remove the trocar, and close the wall by knotting (Figs 14A to N).

## SECOND GROUP

Port closure should be performed under direct visualization of the surgeon, which requires good insufflation of the abdomen. When desufflation is performed, a tactile sense should be used to close the port. These techniques are applicable during insufflation or after desufflation. These techniques include the suture carrier, the dual hemostat technique, the Lowsley retractor, application of bioabsorbable hernia plug in trocar sites.<sup>28</sup> Preliminary placement of fascial stay sutures above and below the prospective trocar site; Foley catheter threaded through the port hole for the elevation of fascial edge upon traction; fish-hook needle improvised out of a hypodermic needle by bending it 180°; Grooved director; U-shaped purse-string suture placed in the fascia around the port hole.<sup>21</sup>

## SUTURE CARRIER

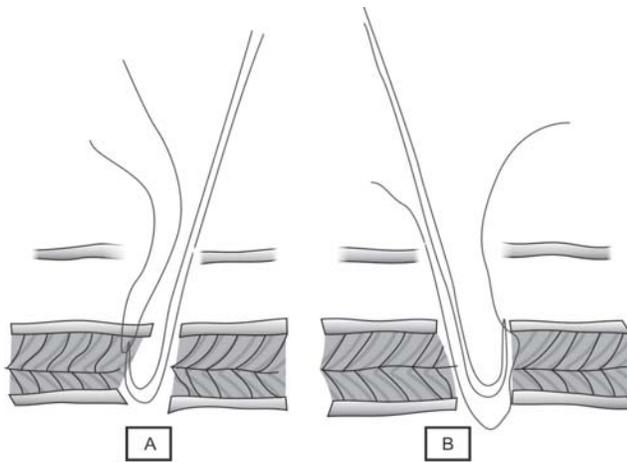
Jorge et al<sup>26</sup> and Li and Chung developed a hook suture carrier (Figs 10A and B) for closure of trocar wounds, making use of the vertical rather than the horizontal space. The suture carrier is a hook suture carrier modified from a simple hook retractor with an eye drilled into the tip through which suture material can be threaded. The handle is 24 cm long, and the size of the hook approximates the size of the general closure needle (CT needle; Ethicon, Somerville, NJ, USA). To begin closure, the fascial edge is lifted vertically with a hook retractor, and the suture carrier is partially inserted into the wound to catch the peritoneum and fascia under direct vision, piercing it from the undersurface (Fig. 10A). A suture (such as 0-polypropylene) is threaded into the exposed eye of the carrier and brought beneath the fascia. This same suture is then carried to the opposite edge of the wound using the carrier, executing a stitch from inside out. After the suture is disengaged from the carrier, a simple stitch is accomplished with the knot on the surface when tied (Fig. 10B).

## DUAL-HEMOSTAT TECHNIQUE

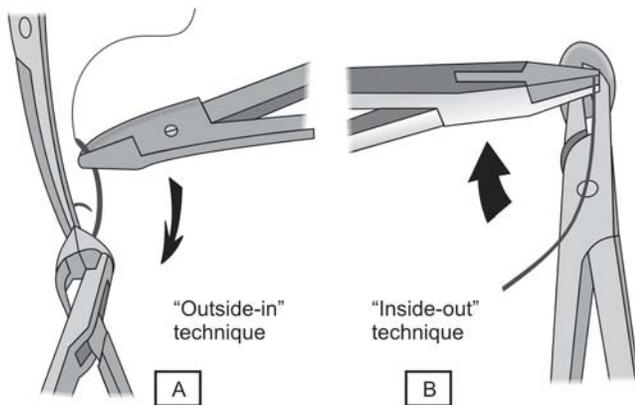
Spalding et al<sup>27</sup> reported the dual-hemostat technique (Figs 11A and B), which is very simple, using two hemostats and a needle driver with suture and needle. The first hemostat is placed into the wound, after which the tips are spread open and the fascia is lifted up away from the underlying abdominal viscera. The second hemostat is used to retract the overlying subcutaneous tissue. Then the suture needle is driven through the fascia to exits between the splayed tips. The procedure is repeated at the opposite side of the wound.

## LOWSLEY RETRACTOR WITH HAND CLOSURE

This technique uses the straight Lowsley retractor (Circon ACMI, Stamford, CT, USA), a regular needle driver, and a



Figs 10A and B: Suture carrier



Figs 11A and B: Dual-hemostat technique

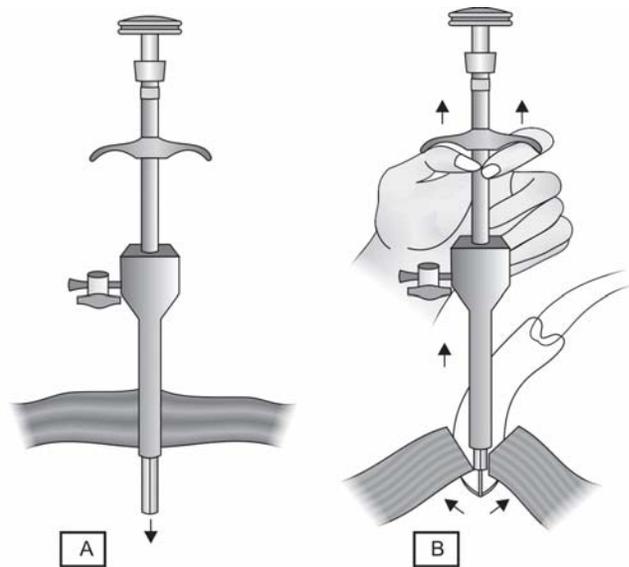
0-absorbable suture on a curved needle.<sup>13</sup> The closed straight Lowsley retractor is passed through the 12 mm port and into the peritoneal cavity (Fig. 12A). The blades of the Lowsley retractor are next opened maximally to 180°. The port then is removed from the abdomen along the shaft of the Lowsley retractor, leaving only the retractor in the wound. The retractor and the port are pulled upward. The fascia is tented toward the skin surface and exposed. A standard hand-sutured closure with 0-absorbable suture then is performed (Fig. 12B).<sup>23</sup>

### PORT PLUG TECHNIQUE

In this technique using the bioabsorbable hernia plug hernin in trocar site, the device was implanted in the umbilical trocar (10 mm) implantation of the bioabsorbable hernia plug device by the safe port possible in all cases.<sup>28</sup>

### DISCUSSION

The port site hernias are found with incidence of 0.23% at the 10 mm port site and 1.9% at the 12 mm port site. This incidence markedly increases to 6.3% for obese patients with a body mass index (BMI) greater than 30.<sup>10, 12, 14</sup> This incisional hernia at a



Figs 12A and B: Lowsley retractor with hand closure



Figs 13A and B: Reverdin and Deschamps needle

trocar site after laparoscopy may arise from failure to reapproximate fascial wound edges, infection, premature suture disruption, a bulge at a previous port site should immediately raise suspicion.<sup>23</sup>

Hernia at trocar ports is classified into three types:

1. The early-onset type (i.e., occurring immediately after the operation, with small-bowel obstruction (especially Richter hernia) frequently developing, (2) the late-onset type (i.e., occurring several months after the operation, mostly with local abdominal bulging and no small-bowel obstruction developing [laparocoele]), and (3) and the special type (i.e., indicating protrusion of the intestine and/or omentum).<sup>20</sup> The Richter hernia usually presents days later, and the patients experience a delay in diagnosis due to persistence of bowel function leading to significant morbidity. This complication of minimally invasive surgery is rare, but

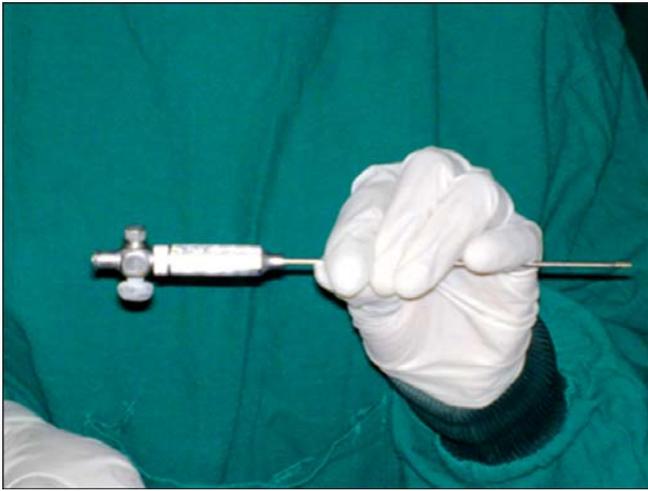


Fig. 14A

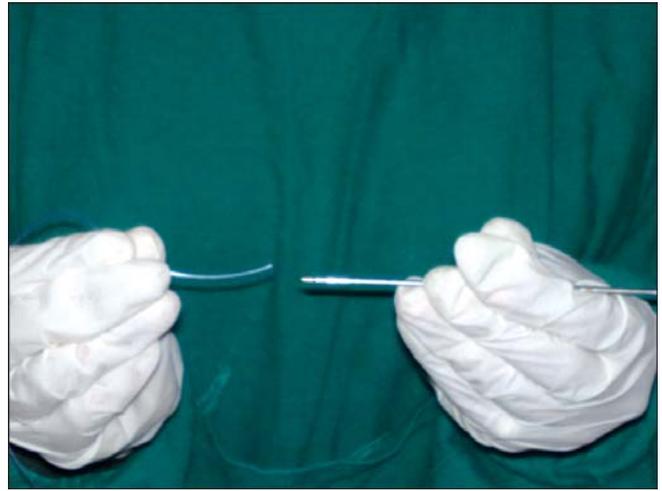


Fig. 14D



Fig. 14B



Fig. 14E

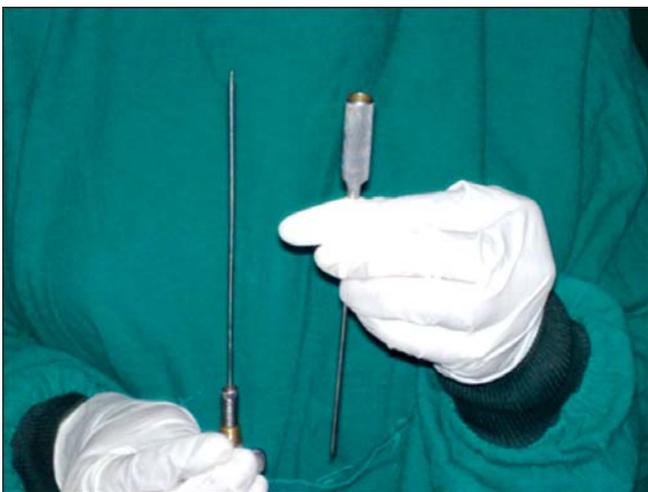


Fig. 14C



Fig. 14F

Fig. 14: Contd...

Contd...



Fig. 14G

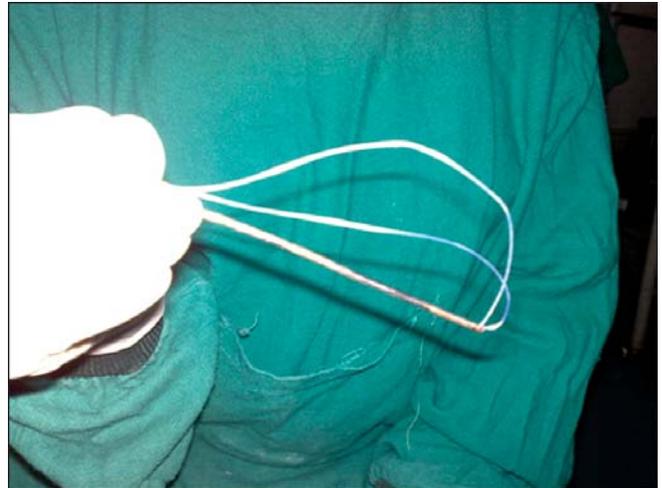


Fig. 14J



Fig. 14H

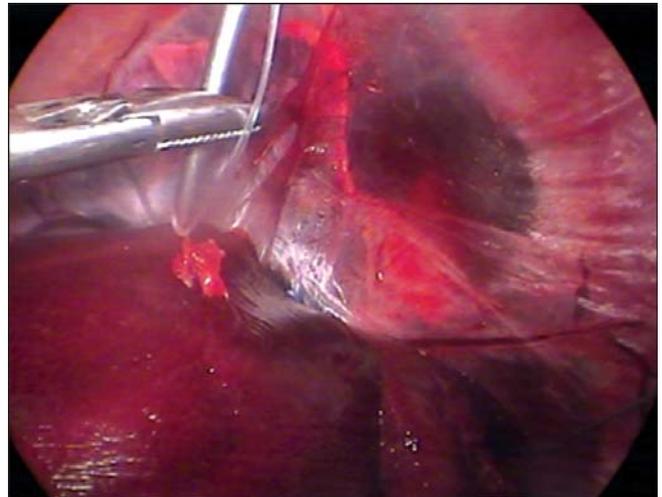


Fig. 14K



Fig. 14I

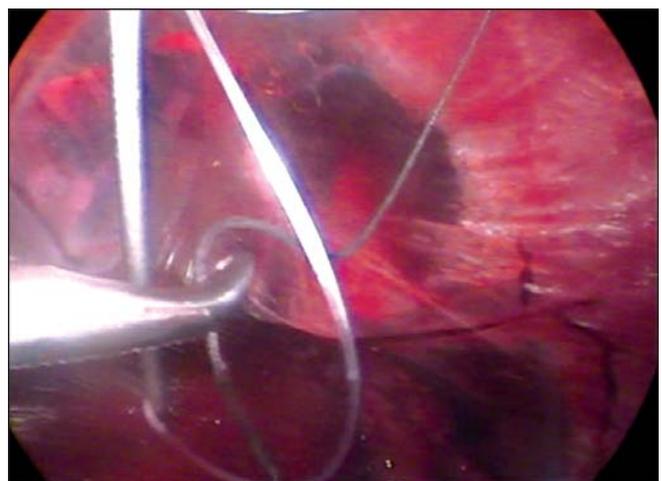


Fig. 14L

Fig. 14: Contd...

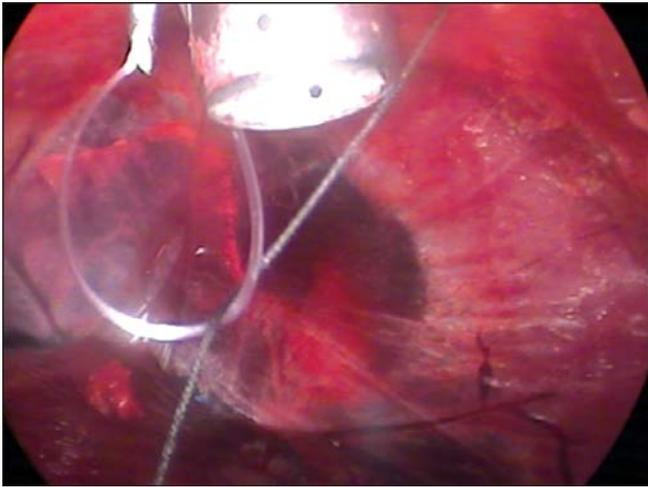


Fig. 14M



Fig. 14N

Figs 14A to N: Veress needle technique for port closure

potentially dangerous. The usual presentation involves crampy abdominal pain with nausea and vomiting. Treatment is by reduction of the bowel that is incarcerated, followed by repair of the fascial defect. Although some authors advocate open repair or local exploration combined with laparoscopy, the laparoscopic approach is acceptable treatment at the time of diagnosis, as long as the incarcerated bowel is not compromised or frankly ischemic.<sup>30</sup> The following risk factors for the development of trocar-site hernias have been identified: The trocar diameter, the trocar design, pre-existing fascial defects, and some operation and patient-related factors.<sup>11</sup> Many authors believe that inserting the 10 mm lateral trocar in an oblique fashion or as a Z-tract will reduce hernia formation by putting the external and internal fascias at different levels,<sup>8-31</sup> so it is recommended that all 10 and 12 mm trocar must be closed. The development of nonbladed obturators with integrated stability sleeves allows for creation of a muscle-splitting dilated laparoscopic port site with minimal abdominal wall defects after removal of trocar sleeves,<sup>32,33</sup> may play a role. There is a debate concerning 5 mm trocar fascial closure, especially in children.<sup>27</sup> Some authors insist that all laparoscopic puncture wounds, even those smaller than 10 mm, should be closed at the fascial level in infants. Kulacoglu,<sup>34</sup> Reardon et al,<sup>25</sup> and Nezhat et al<sup>15</sup> agree that it may not be necessary to recommend routine closure of all 5 mm port sites. However, when such a port has been used for active manipulation during a long operation, closure of the fascia should be considered to avoid hernia, port closure with the maintenance of the pneumoperitoneum during closure keeps the anterior abdominal wall away from the bowel, reducing the likelihood of iatrogenic injury. It also provides easy assessment of adequate closure by the acquisition of a "gas-tight" seal and allows the potential for intraperitoneal inspection of the closed port site via

remaining lateral ports, further ensuring that the bowel is not implicated in the repair, and that homeostasis has been achieved,<sup>35</sup> at the end the perfection of the clouser technique have proliferated and improvements are continuously being made. Practising surgeon should be cognisant of the full range of techniques while familiarizing themselves with the useful ones deemed simple, safe and effective.<sup>36</sup>

The comparisons among these techniques are beyond the aim of this illustrative review, applying a tighter closure of the skin incision may control the leak of the ascetic fluid in patient with ascitis, but for a short-time. The tight closure of fascia will prevent ascitic fluid leak.<sup>6</sup> For closure of the skin, transcutaneous closure with absorbable material seems to be the most suitable technique.<sup>37</sup>

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