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Laparoscopic HIPEC: A bridge between open and closed-techniques

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Abstract

Hyperthermic intraperitoneal chemotherapy (HIPEC) is currently delivered after cytoreductive surgery in patients with several kinds of peritoneal surface malignancies. Different methods for delivering HIPEC have been proposed all of them being variations between two modalities: the open technique and the closed technique. The open technique assures optimal distribution of heat and cytotoxic solution, with the disadvantage of heat loss and leakage of cytotoxic drugs. The closed technique prevents heat loss and drug spillage, increases drug penetration, but does not warrant homogeneous distribution of the perfusion fluid. A novel procedure that combines the advantages of the two techniques by means of laparoscopy is herein presented.

Key words: Cytoreductive surgery, HIPEC, hyperthermic intraperitoneal chemotherapy, peritoneal carcinomatosis, peritoneal surface malignancy

INTRODUCTION

In recent years the treatment of peritoneal surface malignancies is changed, moving from a palliative approach toward an aggressive multimodal therapy, in which a maximal surgical effort to remove as much tumor as possible (cytoreductive surgery [CRS]) is followed by direct instillation of heated intraperitoneal chemotherapy (HIPEC) to address microscopic residual disease.[1]

The technique of CRS, which was first described by Sugarbaker, is widely accepted,[2,3] while several methods are used for delivering HIPEC, all of them being variations between two different modalities, the open (coliseum) and the closed technique, without clear, proven advantage of one method over the other.[4] The open technique assures optimal distribution of heat and cytotoxic solution thanks to manual stirring of the abdominal contents, but has the disadvantage of heat loss (with the need to increase the temperature of the perfusion fluid and expose the bowel to the risk of scald injuries), the risk of leakage of cytotoxic drugs and suboptimal exposure of the anterior parietal wall. The closed technique prevents heat loss and drug spillage, increases drug penetration but does not warrant homogeneous distribution of the perfusion fluid.

We present an original technique in which a laparoscopic approach to the closed abdomen is adopted for stirring the abdominal contents, to achieve optimal distribution of heat and cytotoxic drugs.

PREOPERATIVE PREPARATION

HIPEC is delivered immediately after CRS, which is performed as described by Sugarbaker. Preoperative preparation is done as usual, and no further measures are required.

POSITIONING OF PATIENT AND PORTS

Cytoreductive surgery is performed with the patient in lithotomy position, through a midline incision running from the xiphoid to the pubis.

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At the end of CRS, four Jackson-Pratt drains are inserted in the abdominal cavity: the right superior reaches the right subphrenic space, the right inferior is placed in the hepatorenal recess, the left superior is placed below the left hemidiaphragm, the left inferior is placed in the pelvis [Figure 1a]. The flat end of the drains is cut 8 cm long because excessive length causes floating and dislodgement of the drains during the perfusion of the abdomen. These drains will be used for HIPEC outflow. A purse-string suture is used to secure the drains to the skin and avoid spillage of the perfusion fluid.

A catheter is inserted in the left flank and used for measuring the intra-abdominal pressure (IAP): the dislodgement of the catheter can be avoided by stitching the tip in a declivous position [Figure 1b].

A total of 2 thermal probes are placed through the top and bottom end of the wound, the former reaching the subphrenic space, the latter reaching the pelvis [Figure 1c].

The entire length of the wound, between the xiphoid and the pubis, is divided in four parts, and the skin is closed with four continuous locking sutures. Three 12 mm balloon trocars are placed at the junction between sutures [Figure 2a and b]: Balloon trocars with locking gel cone are preferred (Kii Balloon Blunt Tip®, Applied Medical Resources Corporation), because the sealing capability of the gel cone combined with the action of the inflated balloon minimizes the risk of spillage of the cytotoxic solution through the wound, even with wide articulation of the instruments through the trocars [Figure 2c].

The upper trocar (UT) is connected to the HIPEC inflow tube. The middle trocar (MT) is connected to the heated CO_2 insufflator. The lower trocar (LT) is connected to the smoke evacuator device [Figure 3].

The patient is kept in a flat positioning. The surgeon is on the patient's right side; the assistant stays on the patient's left side; two monitors are placed at the sides of the patient.

OPERATIVE STEPS

The abdomen is filled with the perfusion fluid, calculated in liters by dividing the body surface area (m^2) by 0.43. The temperature of the perfusion fluid is set at 42°C, and the continuous flow is started.

Heated CO_2 is then insufflated through the MT and pneumoperitoneum is established, so that a little working space is created into the abdominal cavity over the surface of the perfusion fluid. The CO_2 pressure should be set according to the value of IAP measured by the IAP catheter and should be approximately 12 mmHg. According to the Stevin's law, the value measured by the IAP catheter is the sum of the CO_2

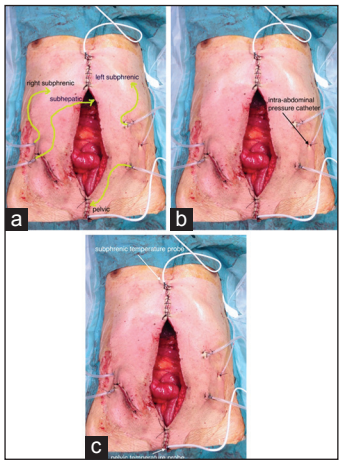

Figure 1: Placement of drains, intra-abdominal pressure catheter, and thermal probes

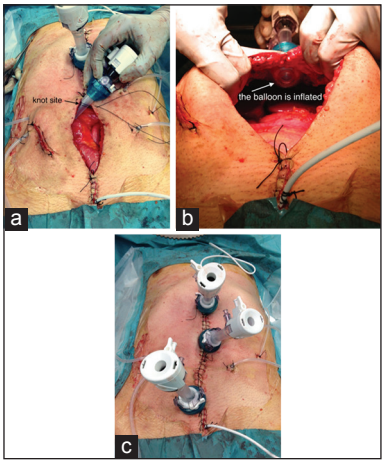

Figure 2: Placement of the balloon trocars

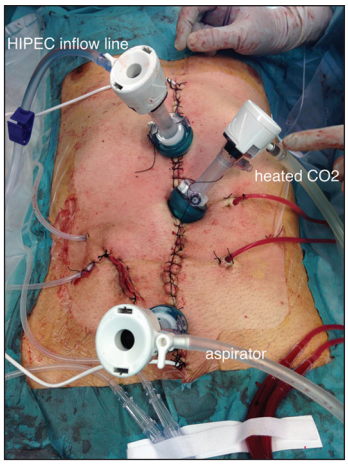

Figure 3: Connections of HIPEC inflow line, CO_2 tube, and smoke aspirator

pressure and the pressure generated by the height of the perfusion fluid (i.e., the distance between the tip of the IAP catheter and the surface of the fluid) [Figure 4]. A 7 mmHg CO_2 pressure is usually sufficient for creating an adequate working space.

The laparoscope is inserted in the UT and the abdominal cavity is inspected: the flow of the perfusion fluid is directly visualized and can be directed under vision following the movements of the laparoscope [Figure 5a and b]. Two 10 mm palpators are introduced in the MT and LT and used to stir the abdominal contents, to expose the serosal surfaces and warrant uniform distribution of heat and cytotoxic drugs [Figure 6a and b]. The laparoscope and palpators can be placed at will through the trocars: one useful chance is using the palpator through the UT to drive the inflowing perfusion fluid in the subphrenic [Figure 7] and hepatorenal spaces [Figure 8]. All regions of the abdominal cavity should be explored, changing the position of the bowel with proper use of the palpators; particular care is taken in opening the subphrenic spaces, the hepatorenal space, and the recesses of the small bowel mesentery. It is important to avoid inadvertent dislocation of the drains and subsequent aspiration of air in the circuit of the HIPEC pump [Figure 9].

After 5 min of stirring, CO_2 insufflation is stopped, the patient is placed in Trendelenburg position and pneumoperitoneum is evacuated under vision through the LT. Perfusion continues in a closed-technique fashion for 10 min, and hence that the anterior surface of the abdomen is also reached by the perfusion fluid: During this phase of perfusion, the abdomen is gently hand-shaken and the inclination of the operating bed is frequently changed, to further promote the distribution of the perfusion fluid into the abdomen.

After 10 min, pneumoperitoneum is again established, and the cycle restarts. A total of 90 min of perfusion time is done alternating 5 min of laparoscopic stirring and 10 min of closed-fashion perfusion. An average intra-abdominal temperature of 41°C is maintained during the entire perfusion time.

At the end, the residual perfusion fluid is evacuated through the drains, and the abdominal cavity is thoroughly washed with saline solution. The trocars, the IAP catheter, and the

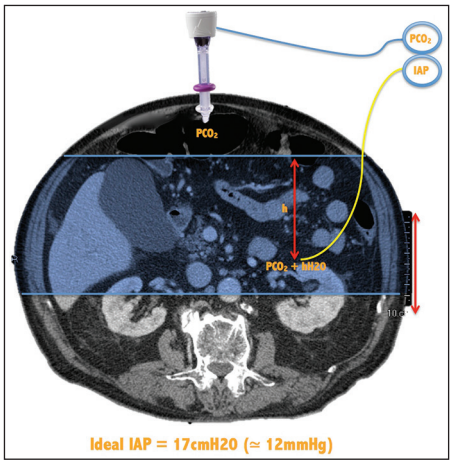

Figure 4: Intra-abdominal pressure values according to Stevin's law

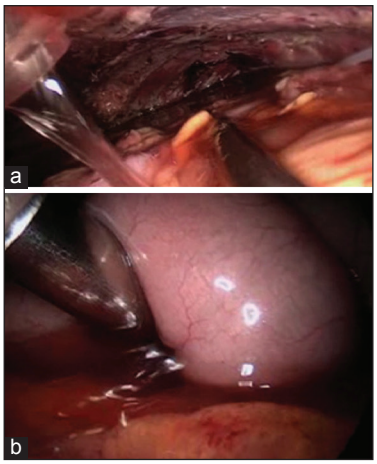

Figure 6: Stirring the abdominal contents with the palpators

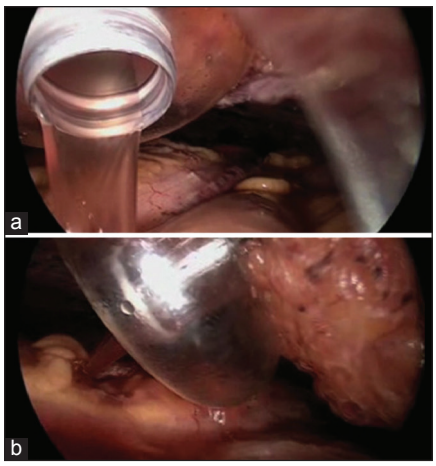

Figure 5: A view of the perfusion fluid inflow

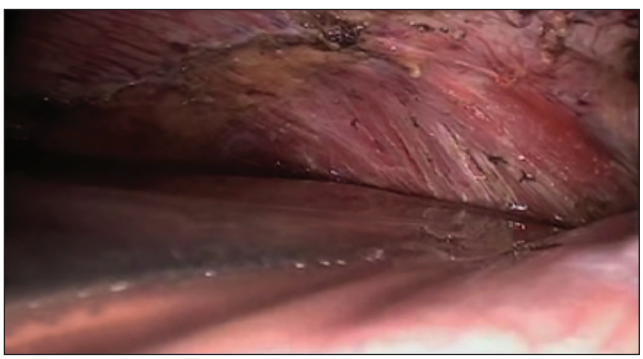

Figure 7: Driving the perfusion fluid over the liver

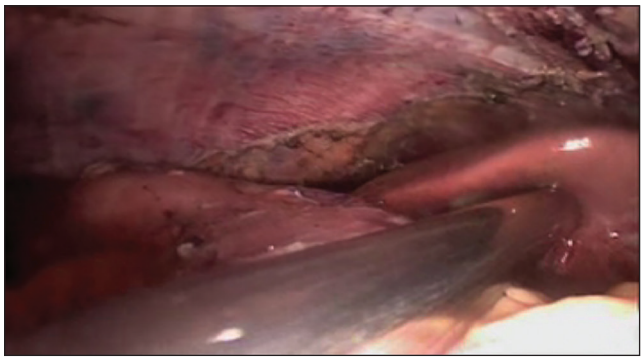

Figure 8: Accessing the hepatorenal space

thermal probes are removed, and the wound is reopened for exploring the abdomen and performing the restorative procedures, as required. The four JP drains are left in place after surgery.

POSTOPERATIVE CARE

Postoperative care is done as required by the extent of CRS and the risk of complications due to HIPEC. No supplementary measures are required due our perfusion technique.

CONCLUSION

Laparoscopy is becoming an important tool for the diagnosis and staging of peritoneal surface malignancies.[5] Laparoscopic CRS is performed with good results for treatment of patients with limited peritoneal disease or malignant ascites and is usually followed by the administration of HIPEC in a closed technique fashion, by means of drains placed under vision through the port sites.[6]

Manual stirring through a hand-assisted laparoscopic device has been reported in a pig model, but is unclear if HIPEC reaches the wide portion of the anterior abdominal wall, which is covered by the device.[7]

Our laparoscopic HIPEC technique is conceived to fill the gap between the open and the closed procedures, by allowing laparoscopic stirring of the abdominal contents during a closed-abdomen HIPEC. The three 12 mm balloon trocars inserted through the sole suture of the skin leave the parietal surface widely exposed; moreover, the balloons are constantly kept in motion, so that their surface in contact with the inner skin is varied. The alternation between pneumoperitoneum-laparoscopic stirring and voiding of the pneumoperitoneum-closed perfusion allow the anterior abdominal surface to be in contact with the perfusion fluid for an adequate lapse of time. Further investigation is needed, particularly regarding the effect of the pneumoperitoneum on the absorption of the cytotoxic drugs. Although the resulting increase in IAP could have a positive effect on penetration of cytotoxic drugs in tissues, this effect is still under study.[7-10]

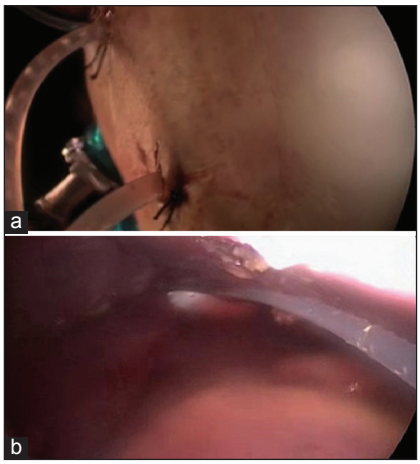

Figure 9: Air aspiration from a floating drain

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