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# Cancer Dissemination during Laparoscopic Surgery: Tubes, Gas, and Cells

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**Abstract. Port-site metastasis has been an unexpected finding after laparoscopic surgery in gastrointestinal cancer patients. No clear explanation exists for this phenomenom. The aims of this study were to evaluate the dissemination pattern in an experimental model of hepatocarcinoma in the rat and summarize current knowledge about the risks and the results of experimental studies on cancer dissemination during laparoscopic surgery. NDA-induced hepatocarcinoma was obtained in Sprague-Dawley rats. Tumors were manipulated during laparoscopy (group 1, $n = 11$) or laparotomy (group 2, $n = 12$). A Medline review of all experimental studies about the risk of cancer dissemination during laparoscopic surgery was undertaken. Both models were associated with implants in parietal wounds [1/11 in group 1 (9%) vs. 1/12 in group 2 (8%), $p$ = NS]. Analysis of the current literature confirms that laparoscopy is associated with abdominal cell mobilization, and cells can be recovered in trocars, filtered exhaust gas, and instruments. Postoperative immunosuppression, the biologic aggressiveness of the tumor, and the gas used for laparoscopy also influence tumoral growth. Port-site metastases are secondary to multiple factors, including the technical skill of the surgeon, the biologic properties of the tumors, and local environmental aspects. Undoubtedly, laparoscopy can help disseminate aggressive tumors and should be reserved for diagnostic and staging procedures or for treatment of low-grade malignant tumors. Therapeutic resection, especially of colon cancer, should be restricted to prospective and randomized trials until there are enough hard data to rule out the clinical importance of this potentially severe complication.**

The explosive success of laparoscopic cholecystectomy has favored the application of laparoscopic surgery (LS) to other surgical gastrointestinal (GI) disorders. Considerable interest has arisen about laparoscopic treatment of GI malignancies (esophagus, stomach, pancreas, or colorectum). Laparoscopy has been proposed for diagnosis and staging and as a technical option for cure or palliation of advanced disease [1, 2].

Surgical techniques for adequate oncologic resection have been well tailored, especially for colorectal surgery [2], and technologic advances (laparoscopic ultrasonography) have enhanced the sensitivity of laparoscopic staging of some tumors (pancreas and liver). In addition, data indicate that the laparoscopic approach is less traumatic [3] and induces minor immunosuppression [4]; and experimental studies suggest that tumor growth after inoculation in the rat is faster after a laparotomy than after a pneumoperitoneum [5]. These data support the use of LS in oncologic patients.

This optimism has been dampened by doubts about the potential role of laparoscopy in dissemination of cancer during the treatment of malignancies, as a number of port-site seeded tumors have been observed [6–9]. Since the first laparoscopic cholecystectomy, more than 100 port-site metastases have been reported, with no clear explanation; these findings challenge the safety of LS for treating cancer [8] (Table 1). The clinical impact of these findings can be determined only after long follow-up of well designed prospective, randomized trials in oncologic patients. Given the difficulties inherent in such trials, this hypothesis has been studied in animal models. The aim of this paper is to review the current knowledge about the hypothetical mechanisms of cancer dissemination during laparoscopic surgery as described in a number of research studies and the results of an experimental model of cancer dissemination using hepatocarcinoma in the rat.

## Materials and Methods

### *Induction of Liver Tumors*

Experimental hepatocarcinomas were induced in 250-g Sprague-Dawley rats by administering NDA [10] (*N*-nitrodiethylamine, N 0756; Sigma Aldrich Química, Madrid, Spain) at doses of 7 mg/kg/day diluted in water and administered ad libitum. The concentration was calculated weekly according to the weight of the rat and the amount of water drunk to achieve a constant dose of 0.007 mg NDA/g body weight. Preliminary analysis in 29 rats showed that after 16 weeks of drug administration all animals developed liver carcinoma, which was easily located on the surface of the liver; they had no extrahepatic disease.

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**Table 1.** Trocar site metastasis after laparoscopic surgery (literature review 1991–1996).

| Surgery type | Therapeutic | Diagnostic | Total |
|---|---|---|---|
| Gynecologic | 12 | 1 | 13 |
| Digestive | | | |
| Cholecystectomy | 41 | 1 | 42 |
| Colorectal | 34 | — | 34 |
| Others | — | 5 | 5 |
| Urologic | — | 4 | 4 |
| Thoracic | 7 | — | 7 |
| Total | 94 | 11 | 105 |

Adapted from Martínez et al. [8], with permission of Minerva Medica.

### *Experimental Groups*

Thirty-four rats were randomly allocated to undergo a laparoscopic (group I) or open abdominal (group II) exploration. In group I, under ether anesthesia, a 12 mmHg $CO_2$ pneumoperitoneum was induced using a standard electronic $CO_2$ insufflator (Storz, Tuttlingen, Germany). A 5-mm trocar was introduced and a explorative laparoscopy performed. Two additional 2-mm trocars were placed in both flanks. A 2-mm arthroscopy forceps (Storz) and an electrocautery probe were introduced through these lateral trocars, and the liver tumors were grasped and coagulated with both instruments. Pneumoperitoneum was maintained for 20 minutes, and the abdomen was then desufflated through the scope port. The orifices in the abdominal wall were closed with a nonresorbable suture for identification by the pathologist.

In group II, a xiphopubic laparotomy was performed. The abdominal cavity was explored without protection of the abdominal wall edges. The surface of the liver tumors were grasped and coagulated in a fashion similar to that in the laparoscopy group, and after 20 minutes the laparotomy was closed with a polypropylene running suture, without rinsing the abdominal cavity.

### *Pathology Study*

Surviving animals were killed 15 days after laparotomy or laparoscopy. The abdominal wall was excised, including all the surgical incisions. The abdominal cavity was explored for the existence of metastasic deposits, and a hepatectomy was performed for histologic analysis. After fixation in formalin, the abdominal wall was explored for cancer deposits, and the laparoscopy ports and the random site of the laparotomy wound were explored by light microscopy after hematoxylin-eosin staining.

## Results

Group I (laparoscopy) included 16 rats, and group II (open) included 18. The postoperative mortality in group I was 25% (4/16) and in group II 38% (7/18) ($p$ = NS). The 12 surviving rats in group I and the 11 in group II were killed 15 days after the surgical procedure. No grossly macroscopic carcinomatosis was observed in any case, but implants in wall scars were observed in two rats.

Microscopic examination showed a moderately differentiated hepatocarcinoma in all cases. In two cases, a wound deposit was observed: one in a rat from the laparoscopy group in which a nodule was observed in a lateral port and the other in the midline incision in a rat of the laparotomy group [1/11 (9%) vs. 1/12 (8%)] ($p$ = NS).

## Discussion

### *Clinical Background*

After the widespread use of laparoscopic cholecystectomy, laparoscopy has been proposed as a useful tool for diagnostic or therapeutic purposes in the workup of several intraabdominal malignancies [1]. Concern arose after the observation of several cases of trocar-site implants in patients in whom an unsuspected gallbladder cancer was found after laparoscopic cholecystectomy [8]. An additional finding was that after laparoscopic cholecystectomy for unknown gallbladder cancer the pattern of intraabdominal spread before reoperation was different, with a higher rate of disseminated carcinomatosis [11, 12].

The observation of implants after laparoscopic operations indicated for oncologic treatment of GI tumors, mainly colorectal cancer, was the greatest source of concern. At present more than 38 cases of port-site implants after laparoscopic colectomy have been reported [8]. Most appeared after surgery for advanced disease, but three were found after operations for Duke's A lesions (4 Dukes D, 15 Dukes C, 11 Dukes B, and 3 Dukes A). Other cases have been reported after thoracoscopic resection of esophageal cancer or urologic cancer (pelvic lymphadenectomy). With this clinical evidence, many authors have deferred therapeutic laparoscopy, mainly for colon cancer, until results of prospective and randomized trials show the procedure to be safe [7].

The exact incidence rate of wound metastasis after laparoscopic or open surgery is unknown. Wound recurrence of GI cancer after open surgery has been classically considered infrequent, with an incidence of less than 1% for colorectal cancer [13]. The cumulative risk of cutaneous seeding after minimally invasive diagnostic procedures (fine-needle aspiration biopsy or tru-cut needle) is low (0.2–0.8%) [8]. Wound site metastasis is around 2% to 4% after laparoscopic colon cancer resection, three times higher than the 0.7% [6, 7, 13] after open colectomy. An analysis of the laparoscopic colon cancer registry of the American Society of Colon and Rectal Surgeons after the recruitment of 504 cases has shown that in a series of 480 cases followed for a minimum of 1 year wound recurrence was observed in 5 cases (1.1%) [14]. A multicenter analysis [15] of a series that included 1333 diagnostic or therapeutic laparoscopic procedures for cancer showed that the port metastasis rate after bile duct or gallbladder cancer was 6.7%, and it was 1.8% after colon cancer, a higher figure than that after open surgery (Table 2). Cook and Dehn [16] found an 11% port-site metastasis rate in a series of 46 laparoscopically evaluated patients with a wide range of abdominal malignancies. Port implants were significantly more prevalent in patients with serosal involvement than in those with lesions at less advanced stages (5/20 vs. 0/26) ($p < 0.05$).

### *Hypothetical Mechanisms*

It is well known that tumor growth is enhanced after surgery, probably due in part to transient immunosuppression and tumor cell mobilization [17] (Table 3), but the reasons for an increased

**Table 2.** Trocar site metastasis after laparoscopic cancer surgery.

| Site of surgery | No. of metastases | | | |
|---|---|---|---|---|
| | Diagnostic | Biopsy | Resection | Trocar implant (%) |
| Pancreas | 107 | 25 | 0 | 1 (0.93) |
| Stomach | 214 | 53 | 19 | 2 (0.86) |
| Biliary tree | 12 | 5 | 18 | 2 (6.67) |
| Colon | 138 | 5 | 601 | 13 (1.76) |
| Kidney | 0 | 0 | 35 | 0 |
| Others | 43 | 16 | 42 | 1 (1.18) |

Data from experience of the Society of Endoscopic Surgery of Great Britain and Ireland [15], with permission of Blackwell Science Ltd.

**Table 3.** Biologic mechanisms that facilitate cell implants in surgical wounds.

| |
|---|
| Stimulation of tumor growth after surgery |
| Transitory immunosuppression |
| Tumor cell mobilization |
| Exfoliation of viable tumor surface cells |
| Facilitation of cell adhesion by wound factors (fibroblasts, collagen, proteoglycans) |

**Table 4.** Biologic mechanisms that facilitate cell implants during laparoscopy.

| |
|---|
| Direct cell implantation in trocar wound |
| Nonprotected and forced tissue retrieval |
| Instrument cell contamination |
| Gaseous turbulence that embolizes cells through wound trocars |
| Hematogenous dissemination and wound trocar implants |
| Modifications in pressure and splanchnic venous flux |
| Spillage of venous emboli due to the increase of intraabdominal pressure |
| Passage of cancer cells from lymphatic to venous system |
| Lymphatic escape to peritoneum from vascular pedicles (clips) |
| Modifications of tumor cell biology by $CO_2$ |

risk of dissemination during LS are not well understood. It has been well demonstrated that tumor cells can exfoliate from the surface of the tumors during surgical procedures. These cells may originate in transmural lesions and in tumors that do not invade the serosa. The cells have the capacity to implant and grow and to establish a metastasis. Furthermore, favorable conditions are needed for implantation of viable cells. Injured tissues (surgical incisions) contain fibroblasts, collagen, and proteoglycans, which facilitate cell adhesion and growth during the first 10 days [18–24].

The most accepted hypothesis is that viable tumoral cells [8, 19, 20] are directly implanted in the wound during unprotected and forced tissue retrieval or by contaminated instruments during tumor dissection (Table 4). However, implants have been observed simultaneously in several port sites other than those from which the specimen was extracted [8, 20].

A basic difference between open and laparoscopic surgery is pneumoperitoneum. During laparoscopy the abdominal cavity becomes a closed, hypertensive, filled recipient that contains a continuous flux of gas that exits through trocar wounds; these wounds represent weak points. It is possible that gas turbulence during lengthy laparoscopic procedures favors the embolization of exfoliated cells during tumor dissection to the port sites. The fact that wound recurrences have also been observed after thoracoscopic operations performed without high pressure lessens the importance of pneumoperitoneum.

Another hypothetical mechanism for port-site metastasis is hematogenous dissemination and implantation of emboli in the wounds. During laparoscopy the splanchnic circulation is modified, with a reduction of 30% of portal flux. It may be that the increased intraabdominal pressure facilitates liberation of emboli or the passage of neoplastic cells from lymphatic to venous vessels through shunts that join the two territories [8]. A mechanism of this kind, however, fails to explain the difference between wound implants during open and laparoscopic surgery. Only 1% of cells that reach the general circulation survive, and only 0.1% of them are able to induce metastasis [22]. Another possibility is that vascular clips may be looser, especially for lymphatic vessels, and spillage of cells may be greater in vascular pedicles [22, 24].

### *Experimental Studies*

While waiting for the results of clinical trials, which require careful design and time if they are to provide significant answers, several authors have investigated the risk of cell dissemination during laparoscopic surgery. The first mechanism studied is the aerosol ability of the pneumoperitoneum; several in vitro models are contradictory (Table 5). Whelan et al. [31] recovered no free melanoma cells injected in the abdominal cavity under pressurized $CO_2$ in the abdomen, although Knolmayer et al. [32] reported recovery of exfoliated peritoneal cells after various levels of intraabdominal $CO_2$ pressure. Taffinder and Champault [33] suggested that smoke particles can act as carriers of clumps of neoplastic cells and can be recovered when exhaled by the trocar orifices due to the high intraabdominal pressure. This finding can explain the implant at trocar sites other than the one used to introduce instruments in direct contact with the tumor. Doudle et al. [34] studied the presence of mesothelial cells or mucosal cells filtered through the trocars in 15 patients in whom the gallbladder (4 cases) or cystic duct (11 cases) were opened during laparoscopic cholecystectomy, and they observed the presence of cells in the instruments in 6 of 15 cases and in the filters of 5 of 15 patients.

Other authors have studied intraabdominal cell kinetics after injection of free cells in the abdominal cavity during laparotomy or laparoscopy. In an in vivo porcine model Hewett et al. [35] showed that after the inoculation of colon cancer cells the cells could be recovered in the filtered exhaust of the trocars (1/30), but more importantly cells were recovered in 20% of trocars and 40% of instruments. Allardyce et al. [36], also using a pig, studied the distribution of HeLa cells labeled with $^{51}Cr$. They observed in both models (with and without pneumoperitoneum) that cells were recovered in operative ports and were distributed throughout the abdomen. The presence of cells depended on the number of cells injected.

The impact of gasless laparoscopic surgery on port implants has been assessed by Watson et al. [30], who observed a reduction of port-site metastases from 83% (10/12) to 25% (3/12), 7 days after manipulation of an abdominal wall induced tumor with injection of breast cancer cells, performed with a wall lifter or $CO_2$ pneumoperitoneum. Tseng et al. [37] have stressed the importance of the mechanical aspects of the abdominal wall hole through which is inserted the trocar in relation to port-site

**Table 5.** Trocar site metastasis after laparoscopic cancer surgery (experimental studies).

| Author | Year | Animal | Tumor type | Inoculum | Days | Implants vs. (laparotomy vs. laparoscopy) | *p* |
|---|---|---|---|---|---|---|---|
| Jones [25] | 1995 | Hamster | Colon cancer | Cecum/peritoneum | 42 | 26% vs. 75% | 0.001 |
| Mathew [26] | 1996 | Rat | Breast cancer | Abdominal wall | 7 | 2/12 vs. 10/12 | 0.005 |
| Hubens [27] | 1996 | Rat | Colon cancer | Peritoneal cavity | 56 | 50% vs. 60% | NS |
| Mutter [28] | 1996 | Rat | Pancreas cancer | Pancreas | | 0/6 vs. 0/6 | NS |
| Targarona/Trias | 1996 | Rat | Hepatocarcinoma | Liver | 15 | 1/12 vs. 1/16 | NS |
| Fritsch [29] | 1997 | Rat | Colon cancer | Cecum | 98 | 25% vs. 48%, laparoscopy gasless vs. $CO_2$ | NS |
| Watson [30] | 1997 | Rat | Breast cancer | Abdomen wall | 7 | 3/12 vs. 10/12 | 0.01 |

implant development. In an experimental model colon cancer cells were injected into the abdomen in rats; a significantly higher amount of tumor was observed in the 5-mm trocar holes that had previously been crushed using a clamp to induce local ischemia compared to that in noncrushed holes. Similarly, abdominal wall hole trocars that permitted $CO_2$ to leak developed larger tumors than did the port sites that were airtight.

Other studies have been designed to observe the pattern of late dissemination of cancer cells after inoculation in the abdomen. Hubens et al. [27] did not find a different pattern of dissemination after colon cancer was inoculated into the abdominal cavity; there were similar growth rates (60%) and implants. However, when a port was introduced, a metastatic implant occurred in 1 of 10 cases. Another model in which pancreatic cells were used showed similar patterns of carcinomatosis after laparotomy or laparoscopy [28], but the carcinomatosis pattern increased if the tumor was manipulated during laparotomy or laparoscopy. The ability of tumor cells to adhere to the intact or disrupted peritoneum was tested by Goldstein et al. [38]. Using bladder cancer cells in a mouse model, these authors showed that after instillation of tumor cells in the abdomen with an intact or injured peritoneum the carcinomatosis rates were 50% and 63%, respectively; but if heparin was added simultaneously the presence of implants fell to 17% and 31%, respectively. This means that cells can adhere to the peritoneum, and such adhesion increases if a raw surface exists. Jones et al. [25], after injection of cancer colon in hamsters and placement of four trocars, showed that wound metastasis appeared in 75% of wound trocars when a pneumoperitoneum was added compared with 25% if the laparotomy was closed without intraabdominal gas, stressing the ability of pneumoperitoneum to mobilize intraabdominal cells.

This study presents a model that bears resemblance to the clinical situations in humans, as does a paper by Mathew et al. [26], which describes establishment of a parietal tumor by injecting cultured breast cancer cells into the abdominal wall. A laparotomy or laparoscopy was subsequently performed and the tumor grasped and manipulated to mobilize tumor cells. Significant increases in the carcinomatosis rate and wound implants were found when a laparoscopy was performed. In our model, we tried to develop a primary tumor to avoid preoperative manipulation of the animal and to mimic the clinical situation. At 15 days after laparoscopy or open surgery we found parietal metastasis in, respectively, 9% and 8% of the two groups of animals.

When criticizing clinical and experimental papers arguing for or against the risk of cancer dissemination during laparoscopic surgery, several variables should be kept in mind. Direct and indirect data suggest that mechanical implantation can occur (deposits in the trocar where the specimen is retrieved, cells observed in trocars and instruments), as can a spray effect (cells isolated in the smoke particles or in trocars other than those in the operative ports). Experimental studies seem to show that exploratory laparoscopy without tumor manipulation does not increase the risk of tumor implantation, and they suggest that technical details (tumor manipulation or morcellation) and stage of disease (serosal involvement or carcinomatosis) can favor cell dissemination.

Other important factors that can influence port-site implants are tumor biology and the intraabdominal environment. From a clinical point of view, it seems clear that aggressive tumors that include peritoneal dissemination in their natural course are more liable to tumor dissemination. Moreover, cells can adhere and proliferate more easily than others in which peritoneal invasion is not as frequent or in which tumor biology is not as aggressive. This may account for the clear-cut difference of implants after gallbladder [11, 12] and colon cancer surgery. It may also explain the differences between the experimental model of Mathew et al. [26] and our study, which used NDA-induced liver carcinoma, a tumor of low aggressive biology that rarely affects the peritoneal serosa [39].

Another issue to be determined is whether laparoscopy per se or components of the laparoscopic procedure affect tumor cell biology (Table 6). It is well known that laparotomy has a greater postsurgical immunosuppressive effect than laparoscopy [4], and that open surgery is followed by greater tumor growth [5] than laparoscopy. Preliminary studies suggest that $CO_2$ stimulates tumor growth in a $CO_2$ environment, more than helium or air pneumoperitoneum or in control animals [41–43]. This new factor adds an element of concern when tumor cells are manipulated in a closed $CO_2$ environment.

We conclude that port-site metastases are secondary to multiple factors, including the technical skill of the surgeon, the biologic properties of the tumor, and local environmental aspects. Undoubtedly, laparoscopy can help disseminate aggressive tumors and should be reserved for diagnostic and staging procedures or treatment of low-grade malignant tumors. Therapeutic resection, especially of colon cancer, should be restricted to prospective, randomized trials until there are enough hard data to rule out the clinical importance of this potentially severe complication.

**Résumé**

Introduction: Les métastases au niveau des orifices de trocart sont une surprise désagréable lorsqu'on pratique la chirurgie laparoscopique abdominale chez le cancéreux. Il n'existe pas

**Table 6.** Tumor growth in various experimental laparoscopic situations in rats.

| Author | Year | Cell type | Control | Laparotomy | Laparoscopy | |
|---|---|---|---|---|---|---|
| | | | | | $CO_2$ | Helium |
| Mutter [28] | 1996 | Pancreas | — | = | = | — |
| Bouvy [40] | 1996 | Colon | — | ≫ | ≪ | — |
| Dorrance [41] | 1996 | Breast | = | — | ≫ | ≫ |
| Jacobi [42] | 1996 | Colon | = | — | ≫ | = |
| Allendorf [5] | 1996 | Breast | — | ≫ | ≪ | — |

=: no changes, ≫: increased tumor growth; ≪: decreased tumor growth, —: not stated.

d'explication claire pour élucider ce phénomène. Buts: 1) Evaluer la pathogénèse du phénomène de dissémination des cellules cancéreuses dans un modèle expérimental de carcinome hépatocellulaire chez le rat; 2) Résumer les connaissances actuelles concernant les risques et les résultats des études expérimentales de la dissémination des cellules cancéreuses pendant la laparoscopie. Matériel et méthodes: 1) On a créé des cancers hépatocellulaires-NDA chez le rat Sprague-Dawley. Les tumeurs étaient manipulées pendant une laparoscopie (groupe 1: n=11) ou pendant une laparotomie (groupe 2: n=12); 2) Grâce à «Medline» on a recherché toutes les publications d'études expérimentales concernant le risque de dissémination de cancer pendant la chirurgie laparoscopique. Résultats: 1) On a observé des métastases pariétales dans les deux groupes (groupe 1: n=1/11 (9%) vs. groupe 2: n=1/12 (8%): p non-significatif; 2) L'analyse de la littérature confirme que: a) la laparoscopie est associée avec une mobilisation de cellules cancéreuses; b) des cellules cancéreuses peuvent être récupérées sur les trocarts et; c) le gaz utilisé pour la laparoscopie influence également la croissance tumorale. Conclusions: Les métastases au niveau des sites de trocarts sont secondaires à de multiples facteurs comprenant la dextérité manuelle, les propriétés biologiques des tumeurs et des aspects particuliers de l'environnement. Sans doute, la laparoscopie est un facteur de dissémination des tumeurs agressives et devrait être réservée aux procédés de diagnostique et de staging ou le traitement des tumeurs de bas grade de malignité. La résection thérapeutique, surtout dans le cancer colique, devrait être limitée aux études prospectives et randomisées en attendant qu'il y a suffisamment de données cliniques pour éliminer le risque accru de cette complication sévère.

## Resumen

Introducción: El desarrollo de metástasis en el lugar de inserción de los trócares ha sido un hallazgo inesperado de la cirugía laparoscópica en pacientes con cáncer. No se ha logrado una explicación satisfactoria del fenómeno. Propósito: 1) evaluar el patrón de diseminación en un modelo experimental de hepatocarcinoma en la rata. 2) resumir el estado actual del conocimiento sobre el riesgo y los resultados de los estudios experimentales sobre diseminación del cáncer durante cirugía laparoscópica. Material y Métodos: 1) se indujeron hepatocarcinomas por NDA en ratas Sprague-Dawley. Los tumores fueron manipulados durante laparoscopia (grupo 1, n:11) o durante una laparotomía (grupo 2 n:12). Se hizo una revisión en Medline de todos los estudios experimentales pertinentes al riesgo de diseminación cancerígena durante cirugía laparoscópica. Resultados: 1) en ambos modelos se observó implantación en la heridas parietales (grupo 1, 1/11 [9%] vs. grupo 2, 1/12 [8%], p = ns), 2) el análisis de la literatura actual confirma que la laparoscopia se asocia con la movilización de células abdominales y que se pueden recuperar células en los trócares, en le gas de exosto filtrado y en los instrumentos, La inmunosupresión postoperatoria, la agresividad biológica del tumor y el gas que se utilice para la laparoscopia, son factores que influyen sobre el crecimiento tumoral. Conclusión: Las metástasis en los sitios de inserción de trócares son secundarias a múltiples factores, que incluyen la habilidad técnica, las propiedades biológicas de los tumores y aspectos ambientales. Indudablemente, la laparoscopia puede ayudar a la diseminación de tumores agresivos y debe mantenerse reservada para procedimientos diagnósticos y de estadificación o para el tratamiento de tumores malignos de bajo grado. La resección terapéutica, especialmente del cáncer del colon, debe restringirse a ensayos prospectivos y randomizados hasta cuando se disponga de la suficiente información sólida que permita conocer la importancia de esta potencialmente grave complicación.

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# Invited Commentary

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Since 1994 numerous editorials and reviews have concluded that laparoscopic radical surgery for cancer (essentially colorectal cancer) should not be performed outside randomized or prospective studies. At the same time, several experimental studies have been conducted to clarify the mechanism of port-site dissemination of cancer after laparoscopy. We are aware of the difficulty of conducting a perfect experimental study in this field, and Targarona et al. should be congratulated. They are among the few to try to come closer to clinical situations. Nevertheless, they failed to show any significant difference between their two groups. In my opinion, it is due to their small sample size and the experimental tumor model used (liver carcinoma) for which peritoneal dissemination is unlikely. Consequently, their conclusions were mostly based on the literature review. I agree with the authors that the risk of port-site metastases is related to the stage and biology of the tumor, but I do not agree with them when they stated that "exploratory laparoscopy without tumor manipulation does not increase the risk." Cases of port-site metastases or peritoneal

carcinomatosis have been reported after laparoscopy without tumor manipulation [1, 2]. The incidence of port-site metastases after colonic surgery has been well discussed in this article. At present there is general agreement that this incidence remains slightly higher than the incidence of wound recurrence after conventional procedures. However, because many operations have been performed worldwide during the last 2 years one may fear that this incidence would be close to the median 4.5% reported in some alarming papers [3].

Several experimental studies are still under way, so we cannot yet draw definitive conclusions regarding the exact mechanism of this complication. We can only suppose that it is probably multifactorial. Among these factors, direct implantation and local ischemia (with production of growth factors) seem important. On the other hand, immune function probably does not play a major role in the pathogenesis of this complication as it is better preserved after laparoscopic surgery [4]. Perhaps local ischemia in the trocar wound reduces this potential benefit of laparoscopic surgery.

In this clinical situation, prophylactic measures appear mandatory, including the no-touch technique, wound protectors and specimen bags, low desufflation, gasless laparoscopy [5] (which is gaining importance despite its technical difficulties), peritoneal lavage with heparin (to prevent free-cell adhesion), and lavage with cytocidal agents. A new technique should not be discredited without a fair hearing, but we all should remember the citation of A.J. Walt: "Operations should not be trophies. They most always be performed for the greater good of the patient—not for the glory of the surgeon" [6].

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