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Pressurized Intraperitoneal Aerosol Chemotherapy (PIPAC): The First Reported Case in Brazil Using Standardized Technique with the Capnopen® Nebulizer Device

Authors' Contribution:
Study Design A
Data Collection B
Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
Literature Search F
Funds Collection G

ABCDEF 1 Eduardo Hiroshi Akaishi
BCDEF 2,3 Diego Greatti Vaz da Silva
BEF 1,2 Helber Vidal Gadelha Lima
DEF 4 Roberta Lages M. Grapperon-Mathis
B 2 Mariana de Souza Arakaki
B 2 Ivan Vinicius Andrade Galindo
B 2 Lucas Afonso Daia
B 2 Gustavo Ferreira Araruna
B 2 André Luiz Torres Oliveira
B 2 Caio Nasser Mancini
ACDE 5,6 Paulo Marcelo Gehm Hoff

1 Department of Surgery, University of São Paulo Hospital das Clínicas, São Paulo, SP, Brazil
2 Department of Surgical Oncology, Oncologia D'Or, D'Or Institute for Research and Education (IDOR), São Paulo, SP, Brazil
3 Department of Surgical Oncology, Mário Covas State Hospital, Faculdade de Medicina do ABC (FMABC), Santo André, SP, Brazil
4 Nove de Julho Hospital, São Paulo, SP, Brazil
5 Department of Oncology, D'Or Institute for Research and Education (IDOR), São Paulo, SP, Brazil
6 Department of Radiology and Medical Oncology, Cancer Institute of The State of São Paulo (ICESP), University of São Paulo Hospital das Clínicas, São Paulo, SP, Brazil

Corresponding Author: Diego Greatti Vaz da Silva, e-mail: dgvsilva@gmail.com
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Patient: Male, 67-year-old
Final Diagnosis: Pancreatic moderately differentiated tubular metastatic adenocarcinoma
Symptoms: Abdominal pain • ascites
Medication: —
Clinical Procedure: Pressurized Intraperitoneal Aerosol Chemotherapy (PIPAC)
Specialty: Oncology • Surgery
Objective: Unusual setting of medical care

Background: Peritoneal metastasis is a common progression of abdominal-pelvic cancers, and it is associated with poorer oncological prognosis when compared to other metastasis sites. Its treatment has limited results, mainly because of poor bioavailability of chemotherapy within the abdominal cavity after systemic administration. Pressurized intraperitoneal aerosol chemotherapy (PIPAC) has been proposed as a novel method to deliver chemotherapy directly into the peritoneal surface; it combines the effectiveness and response of an intraperitoneal therapy with benefits of a minimally invasive approach. The laparoscopic capnoperitoneum is used to instill chemotherapy particles in a more efficient way for distribution and penetration when compared to peritoneal lavage. In the present study, we describe the first PIPAC performed in Brazil, according to the standard technique previously described with the Capnopen® nebulizer device, as well as technique details based on our literature review.

Case Report: A 67-year-old man with pancreatic adenocarcinoma metastatic to the liver at first diagnosis underwent systemic treatment with the FOLFIRINOX protocol. After a major clinical response due to systemic treatment, pancreaticoduodenectomy was performed with resection and radiofrequency ablation of hepatic nodules. After 7 months of follow-up, the patient's condition evolved with symptomatic relapse in the peritoneum. Aiming at better control of this site, multiple PIPAC procedures were performed, showing excellent control of the peritoneal cavity disease. The patient had a sustained response in the peritoneal cavity and showed systemic disease progression 6 months after the first PIPAC procedure, which deceased at 20 months after the first PIPAC procedure and 42 months after the primary diagnosis.

Conclusions: This report shows that the PIPAC procedure is reproducible elsewhere, with safety and good functional results.

Keywords: Chemotherapy, Cancer, Regional Perfusion • Palliative Care • Peritoneal Neoplasms • Surgical Oncology

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Background

Peritoneal metastasis (PM) is a common progression of abdominal-pelvic cancers. It is associated with poorer oncological prognosis when compared with other metastasis sites because of particular characteristics, such as late diagnosis due to lack of initial symptoms and difficult image evaluation, as well as limited effect of chemotherapy due to drug resistance and poor bioavailability within the abdominal cavity after systemic administration [1,2]. Local aggressive treatment with cytoreductive surgery (CRS) and hyperthermic intraperitoneal chemotherapy (HIPEC) is the criterion standard treatment, with curative intent, for few specific histological types of neoplasms, such as pseudomyxoma peritonei and mesothelioma [3,4]. The main rationale is to extract all the macroscopic disease and deliver chemotherapy directly to affected tissues, solving the aforementioned problems [5,6].

However, in the palliative setting, results are poor. Patients may experience pain, ascites, or even bowel sub-occlusion or obstruction, with a tendency to have only a minor response to systemic therapies. Also, patients usually present a poor performance status for a highly invasive procedure, such as HIPEC.

Pressurized intraperitoneal aerosol chemotherapy (PIPAC) has been proposed as a novel method to deliver chemotherapy directly into the peritoneal surface, especially for treatment of patients with advanced and refractory peritoneal carcinomatosis [1,7]. PIPAC combines the effectiveness and response of an intraperitoneal therapy (greater intra-tumoral concentrations and less systemic toxicity) with the benefits of a minimally invasive approach (lower morbidity, easier to repeat, and better quality of life) [8-11]. The laparoscopic capnoperitoneum is used to instill chemotherapy particles in a more efficient way for distribution and penetration when compared to peritoneal lavage [7,12].

In the present study, we describe the first PIPAC performed in Brazil, using the standard technique previously described with the Capnopen® nebulizer device, as well as technique details based on our literature review.

Case Report

A 67-year-old man with a history of right hypochondrium pain in January of 2018 underwent videolaparoscopic cholecystectomy due to cholelithiasis, with an intra-operative finding of hepatic nodules. Biopsy showed a moderately differentiated tubular metastatic adenocarcinoma, compatible with a pancreatic primary neoplasm (HER-2 negative, MLH-1 positive, MSH-2 positive, MSH-6 positive, PMS-2 positive). Investigation and staging showed a primary tumor at the uncinate process of the pancreas with synchronous hepatic metastasis (tumor markers CEA 433 ng/mL and CA 19-9 6.2 U/mL). The only known comorbidity was systemic arterial hypertension. The patient signed an informed consent declaration for publication of the present case report.

He was exposed to FOLFIRINOX protocol (fluorouracil, leucovorin, irinotecan, and oxaliplatin), well-tolerated for 7 cycles. It was discontinued because of thrombocytopenia and modified to the FOLFIRI protocol (fluorouracil, leucovorin, and irinotecan) for another 11 cycles, without major toxicities. Restaging showed a reduction in all hepatic nodules and primary tumor. The case was discussed in a multidisciplinary meeting, and proceeding with surgical treatment was the consensus decision.

The patient underwent laparoscopic evaluation of the peritoneum in October of 2018 without any signs of peritoneal metastasis. The procedure continued with conversion to laparotomy, pancreaticoduodenectomy with resection of a lateral segment of the mesenteric vein, resection of 2 hepatic nodules (segments III and VI), and radiofrequency ablation of other nodules found on intra-operative ultrasound. Pathology showed a residual 2-mm adenocarcinoma with negative margins, no lymph nodes compromised (out of 19 dissected), and no residual neoplasm cells in the resected hepatic nodules. No major surgical complications were registered, and no adjuvant systemic treatment was prescribed.

After 7 months of follow-up, the patient's condition evolved with severe ascites and tomographic signs of hepatic, peritoneal, and retroperitoneal lymph node relapses. Systemic chemotherapy with Gemcitabine and Paclitaxel was prescribed as first-line palliative treatment, for 7 cycles, with a partial response in all metastatic sites. Aiming at better control of peritoneal disease, in November 2019 PIPAC was performed at Hospital Vila Nova Star, Rede D'Or, São Paulo, Brazil. Laparoscopic findings showed ascites (**Figure 1A**), multiple adherences, and few tumor implants (PCI 4) (**Figure 1B-1E**). Ascites cytology was positive for neoplasm cells, and biopsied peritoneal nodules were fibrotic and negative for tumoral cells. PIPAC was performed with cisplatin (7.5 mg/m^2) and doxorubicin (1.5 mg/m^2) for 6 min at 38°C, with a 25-min pause for diffusion (**Figure 1F-1H**). The patient had an excellent recovery and was discharged home on the first postsurgical day without any symptoms.

The patient had acute cholangitis in December of 2019, treated with biliary drainage and hepatic radiotherapy to clear biliary drainage, which delayed later PIPAC procedures. After a full recovery, PIPAC was repeated 2 more times in February and April of 2020, with the same drugs. On these occasions, the superior abdomen had more adherences, no tumoral implants were found (**Figure 2**), and cytology and peritoneal biopsies were negative for neoplasm cells. No postsurgical

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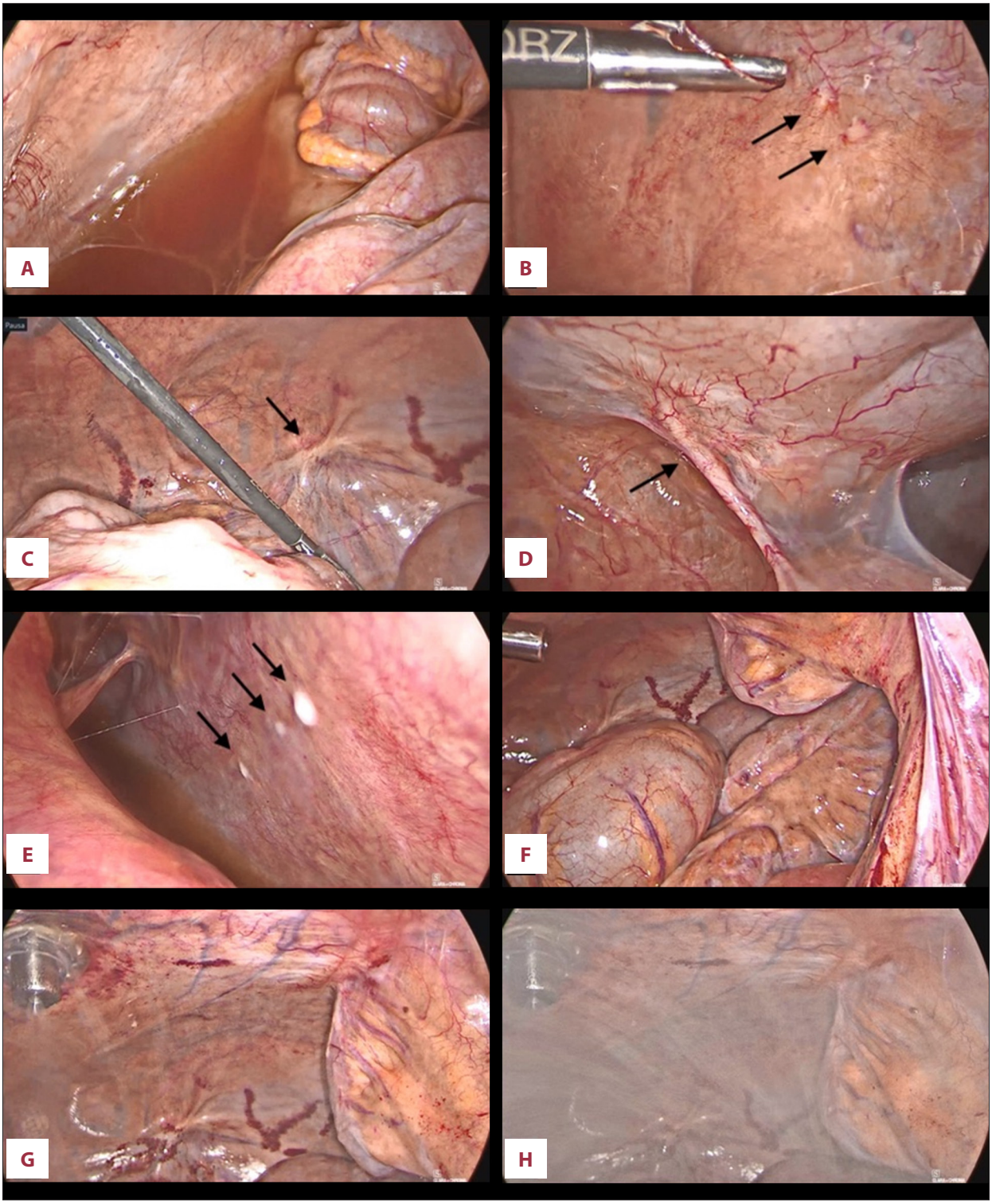

Figure 1. First PIPAC laparoscopic findings. (**A**) Ascites. (**B-E**) Tumor implants. (**F**) Peritoneal cavity before PIPAC. (**G, H**) PIPAC (the white mist seen is the chemotherapy instillation in aerosol form).

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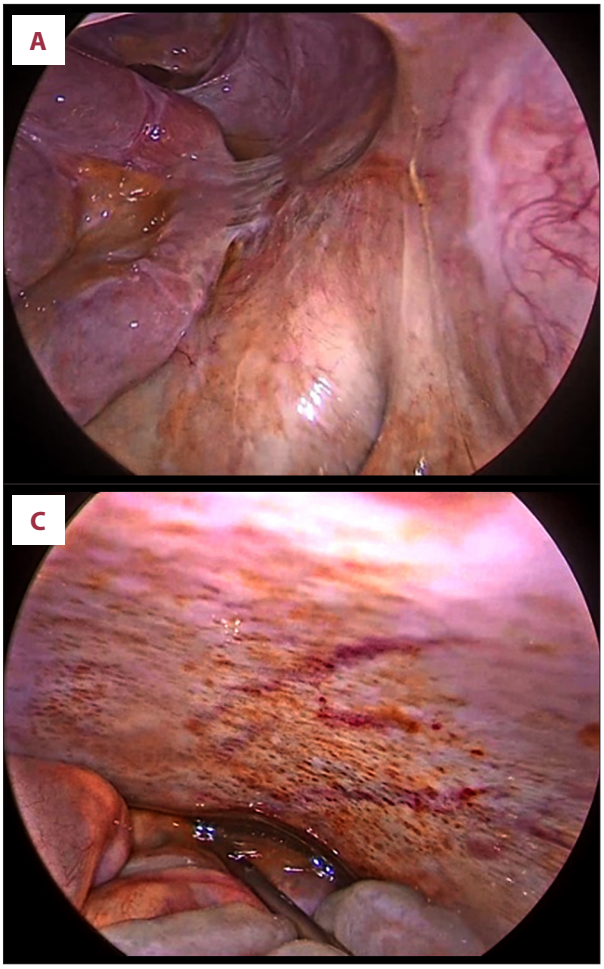

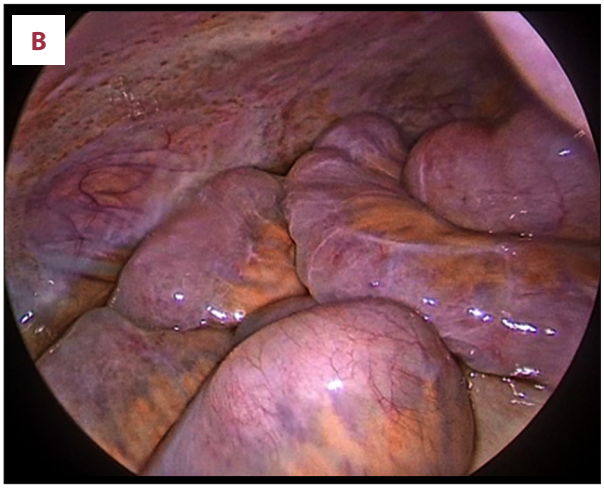

Figure 2. Last PIPAC laparoscopic findings. (**A**) Adherences. (**B**) Small Intestine. (**C**) Parietal peritoneum.

complications were seen. The patient's condition evolved without clinical limitations and an important reduction in ascites (**Figure 3**), but hepatic disease progression was detected at magnetic resonance imaging in May of 2020. Systemic treatment was repeated with Gemcitabine and Paclitaxel.

In July 2020, an emergency hospitalization was required due to intestinal subocclusive symptoms. The patient underwent an exploratory laparotomy with finding of multiple firm adherences between the small intestine and abdominal wall; no viable tumor in peritoneal surface was found, and biopsies were negative for malignancy. A minor enterectomy and enterorrhaphies were necessary for adequate surgical treatment.

Stereotactic body radiation therapy (SBRT) was then performed at the hepatic nodule and suspected mesenteric lymph nodes in October 2020. The patient had another hospitalization due to cholangitis in December, which resolved after administration of parenteral antibiotics. In 2021, the patient's condition

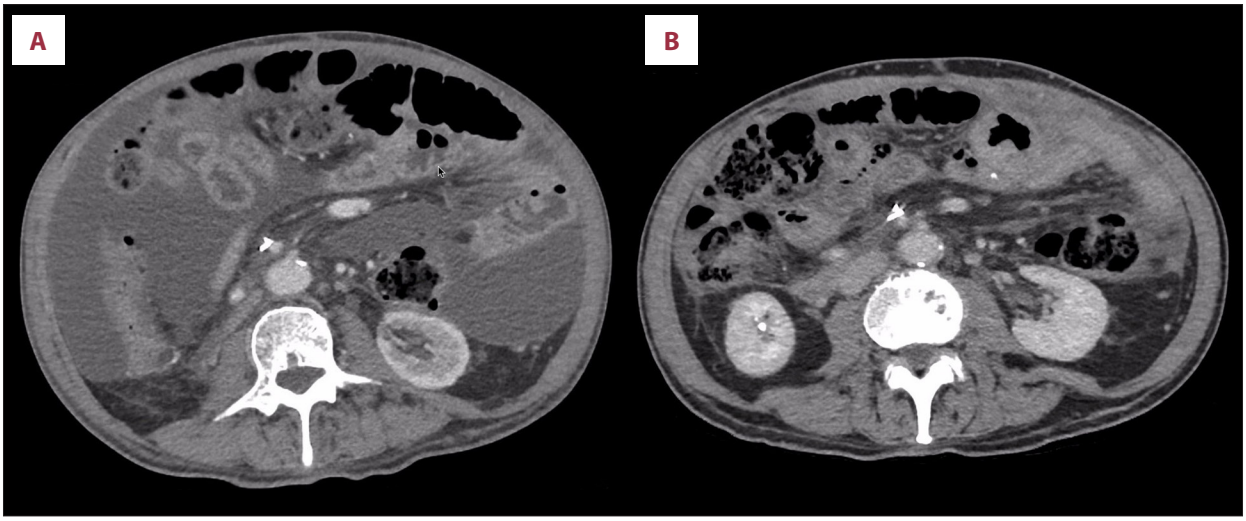

Figure 3. Computed tomography showing ascites evolution. (**A**) At relapse diagnosis (August/2019). (**B**) After the last PIPAC session (May/2020).

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evolved with disease progression to lungs, bones, central nervous system, and lymph nodes, which was treated with supportive therapies. The patient died in July 2021.

Discussion

PIPAC Standardized Technique Description

The PIPAC procedure is performed by laparoscopic access, under general anesthesia, and the recommended antibiotic prophylaxis is cefuroxime and metronidazole [2]. The first laparoscopic port is performed open, closed with a Veress needle, or guided by ultrasound if ascites or adherences are suspected. Pneumoperitoneum is accomplished with regular thermic CO2 gas at a pressure of 12 mmHg [8]. Hasson trocars with a balloon (single or double) are used to avoid accidental mobilization and chemotherapeutic escape during the procedure; a 12-mm trocar in the median infra-umbilical line and an 11-mm lateral trocar are most commonly used [13]. A 30° video optic system provides an adequate view of the procedure, and the peritoneal cancer index (PCI) is calculated [14]. Ascites is aspirated and sent to cytology. At least 4 peritoneum nodules are biopsied to assess the effects of previous therapies. It is recommended to perform biopsies of all 4 abdominal quadrants, and a 2×2 peritonectomy may increase the sensitivity of histologic diagnosis [15].

Chemotherapy instillation is then prepared, in which a 9-mm nebulizer device (Capnopen®, Capnomed, Zimmerrn ob Rhodweil, Germany) is connected to a pressure injector and placed inside the abdominal cavity through a 12-mm trocar. It is essential to exclude any possible chemotherapy leakage that can accidentally expose the patient or surgical team; this is assured with an adequate pneumoperitoneum restraint with zero CO_2 escape flow [16]. In addition, the patient is covered with a sterile plastic cover connected to a high-efficiency particulate air filter (HEPA) that can be turned on during the entire procedure; preferably, it should be performed in a laminar airflow operating room. Chemotherapy is infused remotely with the laparoscopic camera focused on the nebulizer. All medical staff must be outside the room, and patient is continuously monitored by the anesthetist from outside, through a window [17].

PIPAC itself is then performed. Liquid chemotherapy is aerosolized and distributed throughout the peritoneal cavity, which may take 5-8 min, depending on the dose to be administered. The infusion flow must be around 30 ml/min at 37°C, with a maximum pressure of 200 psi (13.8 bar). After infusion, there is a 25-min waiting period for simple diffusion [8,13].

Then, the pneumoperitoneum is evacuated through the HEPA filter system, trocars are removed, and the abdominal wall is closed. By the end of the procedure, it is essential to respect rules for use and disposal of chemotherapy materials (eg, trocars, surgical fields, syringes, serum, and solution sets). If no complications are detected, hospital discharge may be granted on the same day or on the day after surgery. Blood samples are collected on postoperative days 1 and 10 to evaluate toxicity. Assessment of adverse effects is recommended to follow the NCI Common Terminology Criteria for Adverse Events (NCI-CTCAE) [13].

Cytology and biopsies are processed as usual. The histological response can be evaluated using the peritoneal regression grade score (PRGS) [15]. The grade prior to the first PIPAC session is particularly important to assess the response to systemic therapy and is the basis for comparison in subsequent procedures. Quality of life can be monitored with the validated EORTC QLQ C-30 questionnaire before each procedure and every 6 weeks [11,18].

State of the Art

PIPAC has been increasingly used in recent years as an alternative method to deliver chemotherapy directly into the peritoneal surface. Until 2014, when PIPAC's first evidence for efficacy was demonstrated [8], there was no other alternative method to HIPEC for local treatment of peritoneal carcinomatosis. In recent years, it has been widely tested in phase I and II studies [19], for some specific neoplasms such as ovarian [20-22], gastric [23-26], colorectal [27], pancreas [28, 29], biliary tract [30] and mesothelioma [31]. Most studies have shown impressive response rates ranging from 65% to 76% in PCI, 36-88% in histological response, and 50-91% in clinical symptoms [19]. Two-drug regimens are commonly used for PIPAC procedures, depending on the primary tumor site: cisplatin followed by doxorubicin, which had doses defined by a single dose-escalation study is usually used for ovarian, gastric and primary peritoneal cancers, and oxaliplatin as monotherapy extrapolated from HIPEC regimen for colorectal cancers [19,32].

Further evidence has increased researcher interest, with 13 clinical trials in progress registered at ClinicalTrials.gov, including 2 phase III trials with published protocols [33,34], 2 adjuvant trials (for colorectal and gastric cancer), and 1 neoadjuvant trial. Lately, PIPAC's importance in the medical field is growing substantially, as it is shown to be a safe and promising alternative treatment for patients with advanced refractory peritoneal disease. Other indications, such as prophylactic, neoadjuvant, adjuvant, and treatment combinations with systemic therapy, are still to be defined and are in evaluation according to the IDEAL framework [19].

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The present work reports a patient who showed a major and sustained control of peritoneal disease with the 3-PIPACs procedure. No peritoneal relapses or symptoms were detected at follow-up and 20 months of survival were recorded after the first PIPAC, while 9-14-month survival is reported in the literature for pancreatic cancer [19].

To the best of our knowledge, the present study is the first report of a PIPAC procedure performed in Brazil according to the standard technique developed by the German group [8]. In Brazil, there is 1 previously published report of a similar PIPAC procedure using a single-port device [35,36]. This is a deviation of the original technique and the development of a novel device that needs further evaluation and validation.

Conclusions

This report shows that the PIPAC procedure is reproducible, with good safety and good functional results.

Declaration of Figures' Authenticity

All figures submitted have been created by the authors who confirm that the images are original with no duplication and have not been previously published in whole or in part.

References:

1. Solass W, Herbette A, Schwarz T, et al. Therapeutic approach of human peritoneal carcinomatosis with Dbait in combination with capnoperitoneum: Proof of concept. Surg Endosc. 2012;26(3):847-52
2. Sadeghi B, Arvieux C, Glehen O, et al. Peritoneal carcinomatosis from non-gynecologic malignancies: Results of the EVOCAPE 1 multicentric prospective study. Cancer. 2000;88(2):358-63
3. Chua TC, Moran BJ, Sugarbaker PH, et al. Early- and long-term outcome data of patients with pseudomyxoma peritonei from appendiceal origin treated by a strategy of cytoreductive surgery and hyperthermic intraperitoneal chemotherapy. J Clin Oncol. 2012;30(20):2449-56
4. Yan TD, Deraco M, Baratti D, et al. Cytoreductive surgery and hyperthermic intraperitoneal chemotherapy for malignant peritoneal mesothelioma: Multi-institutional experience. J Clin Oncol. 2009;27(36):6237-42
5. Gonzalez-Moreno S, Gonzalez-Bayon LA, Ortega-Perez G. Hyperthermic intraperitoneal chemotherapy: Rationale and technique. World J Gastrointest Oncol. 2010;2(2):68-75
6. Sugarbaker PH, Cunliffe WJ, Belliveau J, et al. Rationale for integrating early postoperative intraperitoneal chemotherapy into the surgical treatment of gastrointestinal cancer. Semin Oncol. 1989;16(4 Suppl. 6):83-97
7. Solass W, Hetzel A, Nadiradze G, et al. Description of a novel approach for intraperitoneal drug delivery and the related device. Surg Endosc. 2012;26(7):1849-55
8. Solass W, Kerb R, Murdter T, et al. Intraperitoneal chemotherapy of peritoneal carcinomatosis using pressurized aerosol as an alternative to liquid solution: First evidence for efficacy. Ann Surg Oncol. 2014;21(2):553-59
9. Robella M, Vaira M, De Simone M. Safety and feasibility of pressurized intraperitoneal aerosol chemotherapy (PIPAC) associated with systemic chemotherapy: An innovative approach to treat peritoneal carcinomatosis. World J Surg Oncol. 2016;14:128
10. Grass F, Vuagniaux A, Teixeira-Farinha H, et al. Systematic review of pressurized intraperitoneal aerosol chemotherapy for the treatment of advanced peritoneal carcinomatosis. Br J Surg. 2017;104(6):669-78
11. Odendahl K, Solass W, Demtroder C, et al. Quality of life of patients with end-stage peritoneal metastasis treated with Pressurized IntraPeritoneal Aerosol Chemotherapy (PIPAC). Eur J Surg Oncol. 2015;41(10):1379-85
12. Khosrawipour V, Khosrawipour T, Kern AJ, et al. Distribution pattern and penetration depth of doxorubicin after pressurized intraperitoneal aerosol chemotherapy (PIPAC) in a postmortem swine model. J Cancer Res Clin Oncol. 2016;142(11):2275-80
13. Nowacki M, Alyami M, Villeneuve L, et al. Multicenter comprehensive methodological and technical analysis of 832 pressurized intraperitoneal aerosol chemotherapy (PIPAC) interventions performed in 349 patients for peritoneal carcinomatosis treatment: An international survey study. Eur J Surg Oncol. 2018;44(7):991-96
14. Sugarbaker PH, Ryan DP. Cytoreductive surgery plus hyperthermic perioperative chemotherapy to treat peritoneal metastases from colorectal cancer: Standard of care or an experimental approach? Lancet Oncol. 2012;13(8):e362-69
15. Solass W, Sempoux C, Detlefsen S, et al. Peritoneal sampling and histological assessment of therapeutic response in peritoneal metastasis: Proposal of the Peritoneal Regression Grading Score (PRGS). Pleura Peritoneum. 2016;1(2):99-107
16. Foster JM, Sleightholm R, Patel A, et al. Morbidity and mortality rates following cytoreductive surgery combined with hyperthermic intraperitoneal chemotherapy compared with other high-risk surgical oncology procedures. JAMA Netw Open. 2019;2(1):e186847
17. Hubner M, Grass F, Teixeira-Farinha H, et al. Pressurized IntraPeritoneal Aerosol Chemotherapy – practical aspects. Eur J Surg Oncol. 2017;43(6):1102-9
18. Aaronson NK, Ahmedzai S, Bergman B, et al. The European Organization for Research and Treatment of Cancer QLQ-C30: A quality-of-life instrument for use in international clinical trials in oncology. J Natl Cancer Inst. 1993;85(5):365-76
19. Alyami M, Hubner M, Grass F, et al. Pressurised intraperitoneal aerosol chemotherapy: Rationale, evidence, and potential indications. Lancet Oncol. 2019;20(7):e368-77
20. Tempfer CB, Celik I, Solass W, et al. Activity of Pressurized Intraperitoneal Aerosol Chemotherapy (PIPAC) with cisplatin and doxorubicin in women with recurrent, platinum-resistant ovarian cancer: Preliminary clinical experience. Gynecol Oncol. 2014;132(2):307-11
21. Tempfer CB, Rezniczek GA, Ende P, et al. Pressurized intraperitoneal aerosol chemotherapy with cisplatin and doxorubicin in women with peritoneal carcinomatosis: A cohort study. Anticancer Res. 2015;35(12):6723-29
22. Tempfer CB, Winnekendonk G, Solass W, et al. Pressurized intraperitoneal aerosol chemotherapy in women with recurrent ovarian cancer: A phase 2 study. Gynecol Oncol. 2015;137(2):223-28
23. Gockel I, Jansen-Winkeln B, Haase L, et al. Pressurized Intraperitoneal Aerosol Chemotherapy (PIPAC) in gastric cancer patients with Peritoneal Metastasis (PM): Results of a single-center experience and register study. J Gastric Cancer. 2018;18(4):379-91
24. Khomyakov V, Ryabov A, Ivanov A, et al. Bidirectional chemotherapy in gastric cancer with peritoneal metastasis combining intravenous XELOX with intraperitoneal chemotherapy with low-dose cisplatin and Doxorubicin administered as a pressurized aerosol: an open-label, Phase-2 study (PIPAC-GA2). Pleura Peritoneum. 2016;1(3):159-66
25. Nadiradze G, Giger-Pabst U, Zieren J, et al. Pressurized Intraperitoneal Aerosol Chemotherapy (PIPAC) with low-dose cisplatin and doxorubicin in gastric peritoneal metastasis. J Gastrointest Surg. 2016;20(2):367-73
26. Struller F, Horvath P, Solass W, et al. Pressurized intraperitoneal aerosol chemotherapy with low-dose cisplatin and doxorubicin (PIPAC C/D) in patients with gastric cancer and peritoneal metastasis: A phase II study. Ther Adv Med Oncol. 2019;11:1758835919846402
27. Demtroder C, Solass W, Zieren J, et al. Pressurized intraperitoneal aerosol chemotherapy with oxaliplatin in colorectal peritoneal metastasis. Colorectal Dis. 2016;18(4):364-71

Indexed in: [PMC] [PubMed] [Emerging Sources Citation Index (ESCI)] [Web of Science by Clarivate]

28. Graversen M, Detlefsen S, Bjerregaard JK, et al. Peritoneal metastasis from pancreatic cancer treated with pressurized intraperitoneal aerosol chemotherapy (PIPAC). Clin Exp Metastasis. 2017;34(5):309-14
29. Khosrawipour T, Khosrawipour V, Giger-Pabst U. Pressurized Intra Peritoneal Aerosol Chemotherapy in patients suffering from peritoneal carcinomatosis of pancreatic adenocarcinoma. PLoS One. 2017;12(10):e0186709
30. Falkenstein TA, Gotze TO, Ouaissi M, et al. First clinical data of Pressurized Intraperitoneal Aerosol Chemotherapy (PIPAC) as salvage therapy for peritoneal metastatic biliary tract cancer. Anticancer Res. 2018;38(1):373-78
31. Giger-Pabst U, Demtroder C, Falkenstein TA, et al. Pressurized IntraPeritoneal Aerosol Chemotherapy (PIPAC) for the treatment of malignant mesothelioma. BMC Cancer. 2018;18(1):442
32. Simone M, Vaira M, Argenziano M, et al. Pressurized Intraperitoneal Aerosol Chemotherapy (PIPAC) with oxaliplatin, cisplatin, and doxorubicin in patients with peritoneal carcinomatosis: An open- label, single-arm, phase II clinical trial. Biomedicines. 2020;8(5):102
33. Bakrin N, Tempfer C, Scambia G, et al. PIPAC-OV3: A multicenter, open-label, randomized, two-arm phase III trial of the effect on progression-free survival of cisplatin and doxorubicin as Pressurized Intra-Peritoneal Aerosol Chemotherapy (PIPAC) vs. chemotherapy alone in patients with platinum-resistant recurrent epithelial ovarian, fallopian tube or primary peritoneal cancer. Pleura Peritoneum. 2018;3(3):20180114
34. Oliver Goetze T, Al-Batran SE, Pabst U, et al. Pressurized intraperitoneal aerosol chemotherapy (PIPAC) in combination with standard of care chemotherapy in primarily untreated chemo naive upper gi-adenocarcinomas with peritoneal seeding – a phase II/III trial of the AIO/CAOGI/ACO. Pleura Peritoneum. 2018;3(2):20180113
35. Seitenfus R, Kalil AN, de-Barros ED, Fedrizzi G. Pressurized Intraperitoneal Aerosol Chemotherapy (PIPAC) through a single port: Alternative delivery for the control of peritoneal metastases. Rev Col Bras Cir. 2018;45(4):e1909
36. Seitenfus R, Kalil AN, de Barros ED, et al. Assessment of the aerosol distribution pattern of a single-port device for intraperitoneal administration of therapeutic substances. Surg Endosc. 2019;33(10):3503-10

Indexed in: [PMC] [PubMed] [Emerging Sources Citation Index (ESCI)] [Web of Science by Clarivate]