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Use of the Cavitron Ultrasonic Surgical Aspirator (CUSA) as a Conservative Surgery Alternative in Benign, Disseminated Peritoneal Mesothelioma

Lasse Leicher[1], Luz Angela Torres-de-la-Roche[2] and Rudy Leon De Wilde[2]*

[1]University of Groningen, Groningen, the Netherlands
[2]Clinic of Gynecology, Obstetrics and Gynecological Oncology, University Hospital for Gynecology, Pius-Hospital Oldenburg, Medical Campus University Oldenburg, Germany
**Corresponding author*

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A B S T R A C T

Benign peritoneal cystic mesothelioma is a rare disease of the abdominal cavity with grape – like cystic lesions, solitary or disseminated. The etiology is unclear, with a neoplastic or reactive origin being the prominent considerations. Because of its high recurrence rate and occasional malignant transformation, radical surgical approaches with optional hyperthermic intraperitoneal Chemotherapy have increasingly been advocated with mixed results. We present a case report with a new conservative approach using the Cavitron ultrasonic surgical aspirator for the first time in benign cystic mesothelioma of the peritoneum and a review of the literature about the treatment of this condition. A 47-year-old female with a history of abdominal surgery, including endometriosis excision and hysterectomy presented with upper abdominal discomfort. Ultrasound and magnetic resonance imaging showed two peritoneal tumors with multiple thin–layered cysts. Exploratory laparoscopy revealed multiple cystic masses. Biopsies showed no malignant cells, no positive markers for borderline – tumors (HEA125) but calretin in positive lining cells as well as PAX8 – positive covering cells, making a benign cystic mesothelioma the most likely diagnosis. The patient exhibited adhesions due to prior surgeries. Because of the high recurrence risk of benign mesotheliomas and the small chances of malignant transformation, we destroyed all cysts using ultrasound vaporization. The patient recovered without complications. Laparoscopic use of the Cavitron ultrasonic surgical aspirator system is a safe procedure with low risks and comorbidity, which minimizes adhesions formation and can be performed as a conservative alternative to currently popular radical therapy in benign peritoneal cystic mesothelioma.

Introduction

Peritoneal benign cystic mesothelioma is a rare disease with unknown etiology in which multiple mesothelial cysts develop in the peritoneum, mostly in the pelvic area but also spread out over all peritoneal organs, sometimes even free floating. A neoplastic origin is assumed by most researchers, though a reactive process could not be ruled out as of yet (Cuartas *et al.*, 2008). The disease itself produces no symptoms, but

swelling of cysts can produce obstruction, constriction, weight gain, shortness of breath and bloating pain.

Depending on the presentation, benign peritoneal cystic mesotheliomas have been operated on due to abdominal discomfort(Cotter, Van Arnam, and Schaffner 2016; Vyas *et al.,* 2012), obstruction(Bray Madoué *et al.,* 2016), localized pain(Wang *et al.,* 2013), misdiagnosis because of their similarity to peritoneal carcinosis (Momeni *et al.,* 2014; Shin and Kim, 2016), and as a preventive measure against malignant transformation and obstruction (Iacoponi *et al.,* 2015). The surgical techniques used include, but aren't limited to open surgery (Iacoponi *et al.,* 2015), laparoscopic excision(Vyas *et al.,* 2012) and even chemotherapy hyperthermic intraperitoneal chemotherapy (HIPEC) (Tentes *et al.,* 2012)).

Though incidental malignant transformation has been reported (González-Moreno *et al.,* 2002; Mino *et al.,* 2014), the survival rate is high, with the risk and comorbidity of surgery itself being a prominent factor, due to the radicalness of the procedure, extensive wound surface and postoperative adhesion formation. Sequela like infertility and induced menopause can be further complications.

Because of those implications, we applied a less invasive procedure, to treat the patient as conservatively as possible, using a laparoscopic approach and for the first time the CUS A ultrasonic vaporization technique.

The CUSA system is a surgical device that uses cavitation, the process of formation of the vapor phase of a liquid when subjected to reduced pressures at a constant ambient temperature, to vaporize tissue high in water content, while not damaging structures that are high in collagen, like nerves, bowels and vessels. The CUSA console generates alternating currents of 24 or 35kHz and is connected to a handheld device, which is embedded with an irrigator and aspirator and can be inserted and operated in the abdominal cavity via laparoscopy. The handheld device converts the delivered energy into vibration of its surgical tip. Tissue is sucked towards the tip and, if high in water content, cells are fragmented and destroyed, simultaneously, tissue debris are directly aspirated. The CUSA system causes no bleeding, producing a dry field of surgery. In our expertise, this technique is a safe and time saving procedure.

Case presentation

A47-year-old female with multiple previous gynecological surgeries, such as two caesarian sections, multiple endometriosis excisions, a laparoscopic myomectomy, and a laparoscopic assisted supracervical hysterectomy 2 years ago, during which we found multiple pseudoperitoneal cysts on uterus, adnexa and bladder. The histopathological diagnosis was stated as benign mesothelial cysts. One year ago, she was referred with vague upper abdominal discomfort and a suspicious peritoneal tumor on gynecological ultrasound. A magnetic resonance imaging (MRI) confirmed the presence of a peritoneal tumor and revealed an additional tumor of unclear origin on the left abdominal wall with multiple thin – layered cysts in the middle and upper abdomen. The patient underwent diagnostic laparoscopy showing multiple peritoneal adhesions, a subfascial 1cm fixed tumor and multiple cysts in the middle and upper part of the omentum majus. Additionally, the douglas pouch, the liver area, the pelvic walls and adnexa showed multiple cysticmasses and cysts (Picture 1).

Extensive adhesiolysis and excision of the subfascial tumor and debulking peritoneal masses on omentum majus and Douglas pouch was performed. The additional tumor spotted earlier on magnetic resonance imaging was diagnosed as a multicystic left ovary and left in situ, as were smaller cystic masses, due to intraoperative uncertainty of the dignity of the cystic masses. Multiple biopsies were taken, which later revealed no malignant cells, positive reactions for AE1/AE3, negative for D2-40, nuclear positive for WT-1, solitary positive reactions for Ki67 (focal 5 %), negative reactions for estrogen receptors and positive reactions forcalretinin and PAX – 8. At this point, a definitive diagnosis was not possible. Differential diagnosis included serosal and endosalpingeal cysts due to chronic fibrosing pelviperitonitis and benign cystic mesothelioma of the peritoneum.

A second laparoscopy was performed nine days after. After an extensive adhesiolysis, the bigger masses and about 75% of all cysts and cystic masses were resected. Defects on the serosa of terminal ileum and ascending colon were single – stitched. Final pathology confirmed benign cystic mesothelioma of the peritoneum.

After consulting with the patient and explaining the alternative options, minimal invasive surgery was chosen as shared consent. Since the disease shows a disseminating behavior while being benign in its nature with a low chance of malignant transformation, our goal was to offer the patient a conservative, low risk option, reducing of future complications, but therefore not pursuing complete remission. Because the cysts have a fragile surface, we hypothesized, that ultrasonic vaporization with the Cavitron Ultrasonic Surgical Aspirator (CUSA) via laparoscopy could be able to destruct the disseminated cysts without damaging the nerves, bowels and vessels, and giving little chance to adhesion formation. The patient gave her consent, having fully understood the small risk of malignant transformation.

Three months later she underwent laparoscopic surgery which revealed extensive adhesions, multiple cystic masses all over the abdominal cavity and organs, and a 5 cm tumor in proximity to the sigmoid. After extensive adhesiolysis and resection of the tumor, it was possible to vaporize all the cysts, except for some cystic masses located on the omentum in close proximity to the transverse colon because of the risk of perforation without informed consent of the patient(Pictures 2 and 3) using the CUSA system. The ultrasound vaporization did not produce bleeding. Pathology again confirmed benign cystic mesothelioma. The patient recovered without complications.

The following laparoscopic surgery was performed two months later, showing re-emergence of peritoneal adhesions in the pelvic area but no additional adhesions from other sites where cysts were vaporized. Multiple small cysts were visible on the peritoneal lining, Omentum and diaphragm, but mostly inside the pelvic area (Picture 4). Adhesiolysis, ovarian cystectomy and resection of a 5 cm mesotheliomal tumor close to the transverse colon were performed. All mesothelial cysts were vaporized (Picture 5). After the procedure, the patient recovered without complications. As hypothesized, ultrasound vaporization did not produce bleeding, perforation or adhesions. The patient was satisfied with the procedure and its results. She will be monitored by ultrasound, if necessary, additional laparoscopic vaporization will be scheduled.

Results and Discussion

To put the case study and approach into perspective, we looked at all studies published about benign peritoneal cystic mesothelioma in Pubmed, Google Scholar and Smartcat. We found no case control study and no study about the use of the CUSA system. We then selected all publications that met the following criterion: being published in the past 5 years, being cited multiple times. Being 67 articles filled our selection criteria, with a total of 131 patients (Table. 1).

Regarding therapy, all but one case used radical techniques, ranging from wide excision as the mildest up to cytoreductive surgery with additional HIPEC as the most invasive. 29% of patients underwent additional HIPEC and 6,9% had pure laparoscopic surgery. One patient refused treatment. No report about the use of CUSA was found. Incidentally, novel approaches were used like intraoperative laser (Rosen and Sutton 1999) and tamoxifen (Letterie and Yon 1998) but they didn't show the expected effectivity: The patient treated with laser was disease – free for 11 months but not followed for a longer period and the initial effectivity of tamoxifen was seen as incidental since mesothelial cysts show no hormone receptors in most cases (Sawh *et al.,* 2003). Of all 131 patients, 37,3% of patients had a follow – up period of less than 6 months. 16,8% had a recurrence, with a malignant transformation in 2,2% of patients. Contrary to those findings, a rate of recurrence of 27-75% and around 50% has been reported in the literature (Momeni *et al.,* 2014; Söreide *et al.,* 2006), sometimes years after remission. We assume that the short follow – up period in many case studies show a biased picture and are not indicative of general disease progression. Therefore, necessary repeated surgery remains likely.

In the subgroup of 38 HIPEC patients, 15,8% had a follow up period of less than 6 months, one (2,6%) had a recurrence, one (2,6%) had a malignant transformation. Due to the large variation in follow – up period reported within and across case series and studies, however, we can only tentatively conclude, that HIPEC surgery is superior in respect to disease recurrence, but there remains a substantial risk of necessary additional surgery. Therefore, longer and more consistent follow up periods in future case studies and a more comparable way of reporting are required.

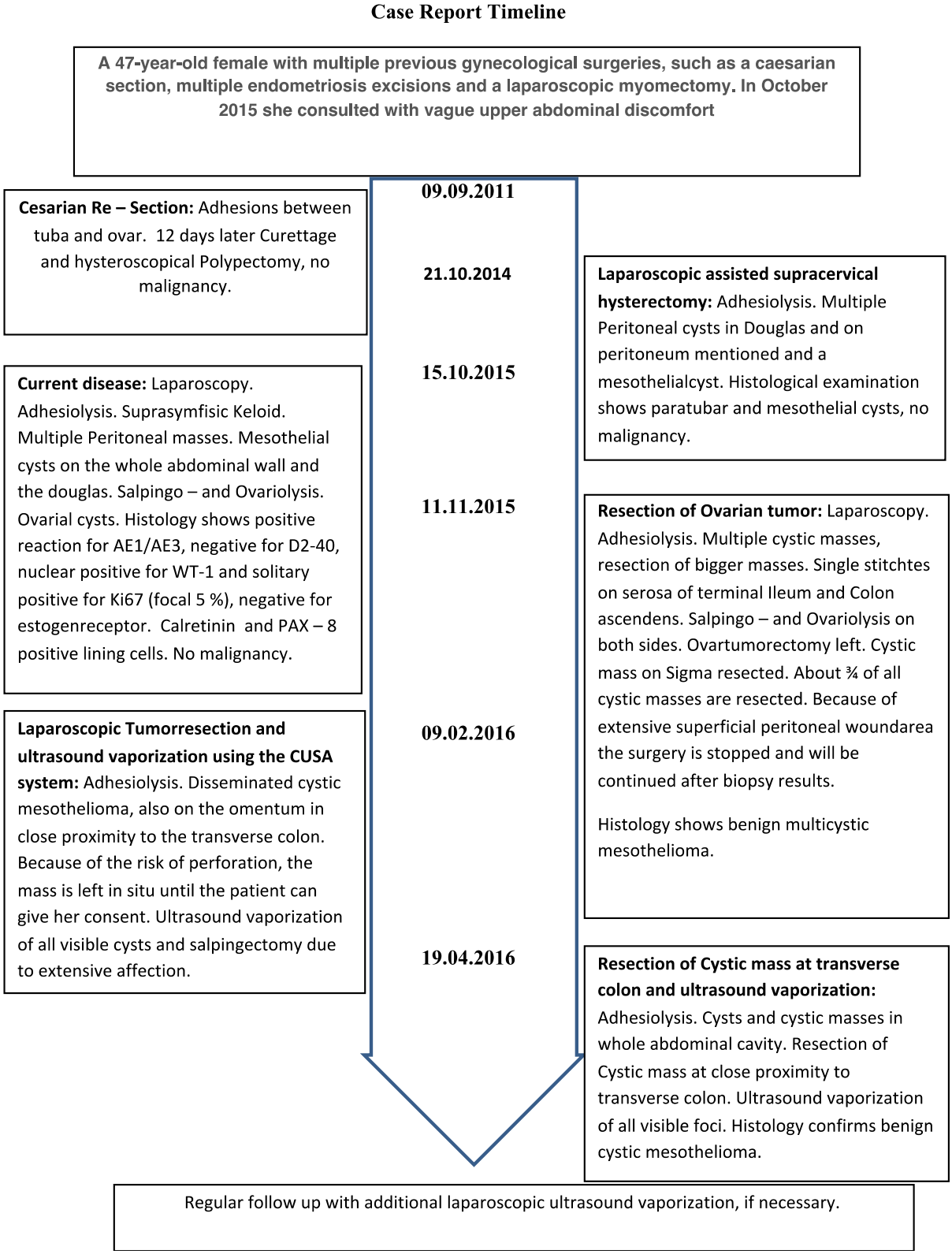
We could only find 3 case reports of malignant transformation (González-Moreno *et al.,* 2002; Mino *et al.,* 2014; Sethna *et al.,* 2003), one of which showed both benign and malignant cells within the same tumor, questioning whether the patient really had benign cystic mesothelioma which transformed, or a primary malignant process. Therefore, we see little added value of radical surgery with HIPEC in terms of prevention of malignant transformation.

The CUSA system is used for surgery on tissue with high water and low fiber content. Based on our experience with this system, we postulated it to be a safe option, as an alternative treatment for patients who can't undergo or refuse radical surgery. Using the CUSA system, we were able to destroy all visible mesothelioma cysts with the advantage of not producing bleeding or perforation of affected organs during surgery. Contrary to radical operations, the procedure is also time – effective. Additionally, we had the opportunity to control the results in the same patient, which showed no adhesion formations on the sites that were vaporized, re – emerging cysts being of smaller quantity and quality and able to be ablated again. Additionally, the recovery of the patient was uneventful, being very satisfied with the results.

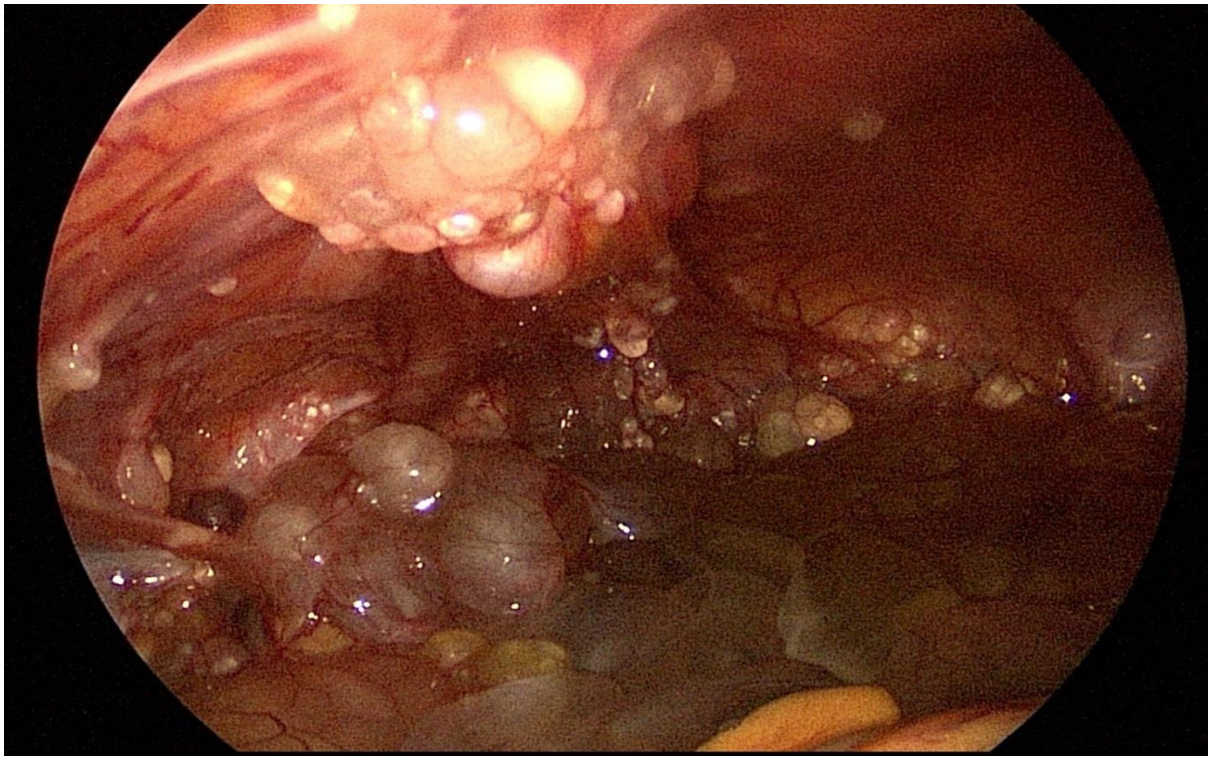
Table.1 Case studies and series about Mesothelioma to reflect current surgical possibilities, we researched all case studies from the last 5 years plus the most important studies in history based on citation in current case studies. Pub is the Publication date; Follow – up is the average in months per case; # Rec is the number of cases with a recurrence; #Malig is the number of cases which had a malignant transformation.

#	Pub	First author	Kind	Surgical technique	# Patients	Disease presentation	Follow - up	# Rec	# Malig
1	1982	Y Katsube	Case series	Laparotomy	5	Solitary and disseminated cysts	37,6	2	0
2	1984	G Philip	Case series	Laparotomy	2	Solitary and disseminated cysts	24	1	0
3	1988	F Raafat	Case study	Laparotomy	1	Solitary cystic mass	12	0	0
4	1998	Charles V Pollack	Case study	Laparotomy, Tamoxifen	1	Multiple solitary cystic masses	0	0	0
5	1999	S Gonzales-Moreno	Case study	Laparotomy	1	Cystic masses	120	1	1
6	2002	S Somasundaran	Case study	Laparotomy	1	Cystic masses	0	0	0
7	2002	K Sethna	Case Series	Laparotomy, HiPEC	5	Cystic masses	0	0	1
8	2002	M H Kanstrup	Case series	Laparotomy/ Laparoscopy	3	Multiple cysts	17	1	0
9	2003	S Ravindranauth	Case series	Laparotomy	17	Solitary and disseminated cysts	75	5	0
10	2003	Gerard S. Letterie	Case study	Laparotomy	1	Solitary cystic mass	90	1	0
11	2003	D M B Rosen	Case study	Laparotomy, KTP Laser	1	Solitary cystic mass	12	1	0
12	2003	H Abdullahi	Case study	Laparoscopy	1	Cystic masses	36	1	0
13	2005	S van Ruth	Case study	Laparotomy	1	Solitary cystic mass	32	0	0
14	2006	K Urbañczyk	Case series	Technique not mentioned	6	4 Solitary, 2 disseminated	22	0	0
15	2007	M C Safioleas	Case study	Laparotomy	1	Multiple cysts	24	0	0
16	2008	J E Cuartas	Case study	Laparotomy	1	Solitary cystic mass	36	0	0
17	2009	S Saad	Case study	Mini Laparotomy	1	Solitary cystic mass	24	0	0
18	2009	E M Bernstein	Case Series	Laparotomy/ Laparoscopy	3	Cystic masses	16	1	0
19	2009	P J Koo	Case study	Laparotomy	1	Cystic masses	0	0	0
20	2010	N Üzüm	Case study	Laparotomy	1	Disseminated Cysts	24	0	0
21	2010	A Limone	Case study	Laparoscopic excision	1	Solitary cystic mass	0	0	0
22	2010	P Hollington	Case study	Laparotomy	1	Cystic masses	18	0	0
23	2010	V Pinto	Case study	Laparoscopic excision	1	Multiple cysts	24	0	0
24	2010	T C Chua	Review	Laparotomy, HiPEC	26	Solitary and disseminated cysts	53	1	0
25	2011	X Pitta	Case study	Laparotomy	1	Solitary cystic mass	6	0	0
26	2011	L Ekanath	Case study	Laparotomy	1	Solitary cystic mass	12	0	0
27	2011	S Iacoponi	Case study	Laparotomy	1	Cystic masses	12	0	0
28	2011	I Jouvin	Case study	Laparotomy, HiPEC	1	Cystic masses	0	0	0
29	2011	A Cavallo	Case study	Laparotomy	1	Solitary cystic mass	0	0	0
30	2011	H D Shin	Case study	Wait and see	1	Cystic masses	2	1	0
31	2011	A C Testa	Case study	Laparoscopic excision	1	Disseminated Cysts	0	0	0
32	2011	A Husain	Case study	Laparotomy	2	Cystic masses	0	0	0
33	2011	M Dzieniecka	Case study	Laparotomy	1	Cystic masses	0	0	0
34	2012	D Vyas	Case study	Laparotomy	1	Solitary cystic mass	6	0	0
35	2012	E Canbay	Case study	Laparotomy	1	Solitary cystic mass	180	1	0
36	2012	A Gyang	Case study	Laparotomy	1	Solitary cystic mass	0	0	0
37	2012	A A Tentes	Case study	Laparotomy, HiPEC	1	Disseminated Cysts	12	0	0
38	2013	A Gupta	Case study	Laparotomy	1	Solitary cystic mass	0	0	0
39	2013	T B Wang	Case study	Laparotomy	1	Solitary cystic mass	6	0	0
40	2013	H Elbouhaddouti	Case study	Laparotomy	1	Solitary and disseminated cysts	0	0	0
41	2013	O Akbayir	Case study	Laparotomy	3	Solitary cystic mass	37	0	0
42	2013	T D Witak	Case study	Laparotomy	1	Multiple cysts	10	0	0
43	2013	T A Apostolos	Case study	Laparotomy, HiPEC	1	Solitary cystic mass	12	0	0
44	2013	Y Kurisu	Case study	Laparoscopic excision	2	Disseminated Cysts	12	1	0
45	2013	G D Bakshi	Case study	Laparotomy	1	Solitary cystic mass	126	1	0
46	2013	J H Hong	Case study	Laparotomy	1	Cystic masses	3	0	0
47	2013	E Latha	Case study	Laparotomy	1	Disseminated Cysts	12	0	0
48	2013	S Ishigami	Case study	Laparotomy	1	Multiple solitary cystic masses	12	1	0
49	2014	H Momeni	Case study	Laparotomy	1	Solitary cystic mass	12	0	0
50	2014	J Mino	Case study	Laparotomy	1	Solitary cystic mass	4	1	1
51	2014	S Takemoto	Case study	Laparotomy	1	Cystic masses	9	0	0
52	2014	A A Zain	Case study	Laparotomy, HiPEC	1	Cystic masses	0	0	0
53	2014	O Sizzi	Case study	Laparoscopic excision	1	Solitary cystic mass	0	0	0
54	2014	D Sahu	Case study	Laparotomy	1	Solitary cystic mass	6	0	0
55	2015	R Lee	Case study	Laparotomy	1	Solitary cystic mass	0	0	0
56	2015	I Jouvin	Case study	Laparotomy, HiPEC	1	Solitary and disseminated cysts	0	0	0
57	2015	H Jerraya	Case study	Laparotomy	1	Solitary and disseminated cysts	24	0	0
58	2015	R Monteiro	Case study	Laparotomy	1	Cystic masses	9	0	0
59	2015	V A Tamhankar	Case study	Laparotomy	1	Solitary cystic mass	5	0	0
60	2015	P F Eire	Case study	Laparotomy	1	Disseminated Cysts	60	0	0
61	2015	M Khurram	Case series	Laparotomy, HiPEC	2	Multiple solitary cystic masses	0	0	0
62	2016	S Occhionorelli	Case study	Laparotomy	1	Solitary and disseminated cysts	12	0	0
63	2016	K BMadoué	Case study	Laparotomy	1	Solitary cystic mass	0	0	0
64	2016	J A Snyder	Case study	Laparotomy	1	Cystic masses	0	0	0
65	2016	T G Cotter	Case study	Laparotomy	1	Solitary cystic mass	3	0	0
66	2016	A V P Neto	Case study	Laparotomy	1	Disseminated Cysts	20	1	0
67	2016	A E Geidie	Case study	Laparoscopic excision	1	Solitary cystic mass	10	0	0

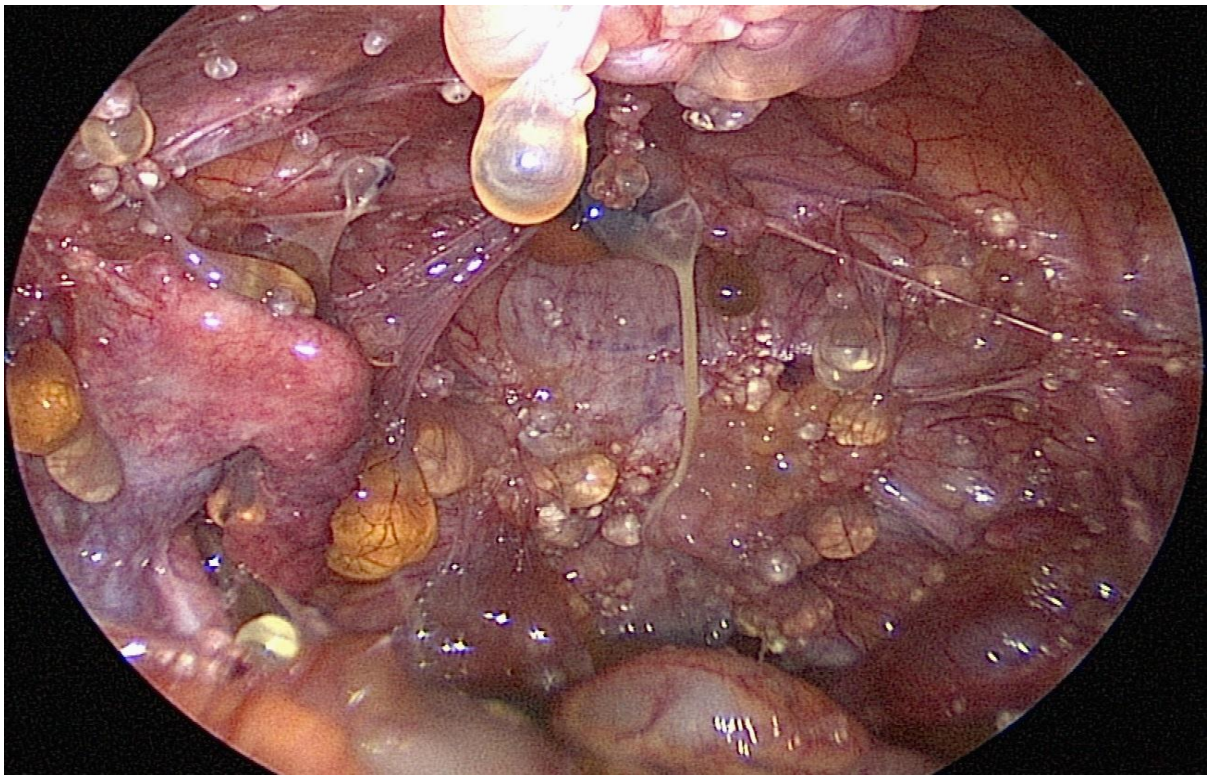
Fig.1 Case Report Timeline



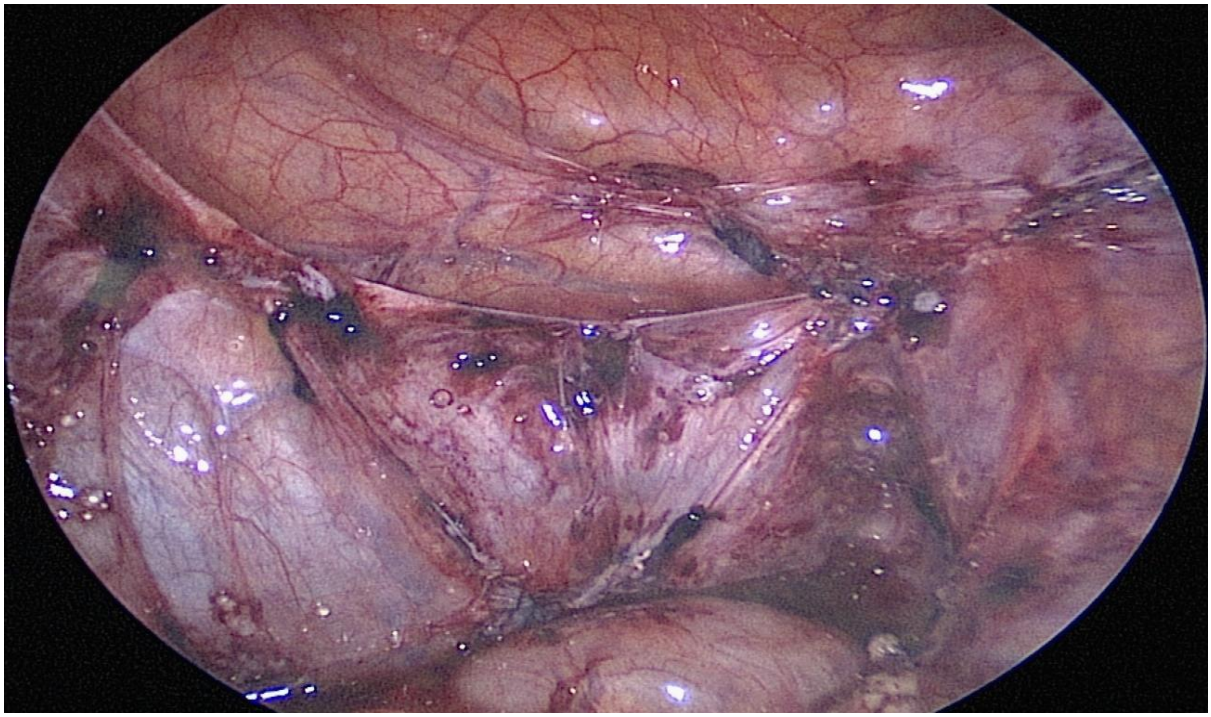
Picture.1 Cyst dissemination at first laparoscopy



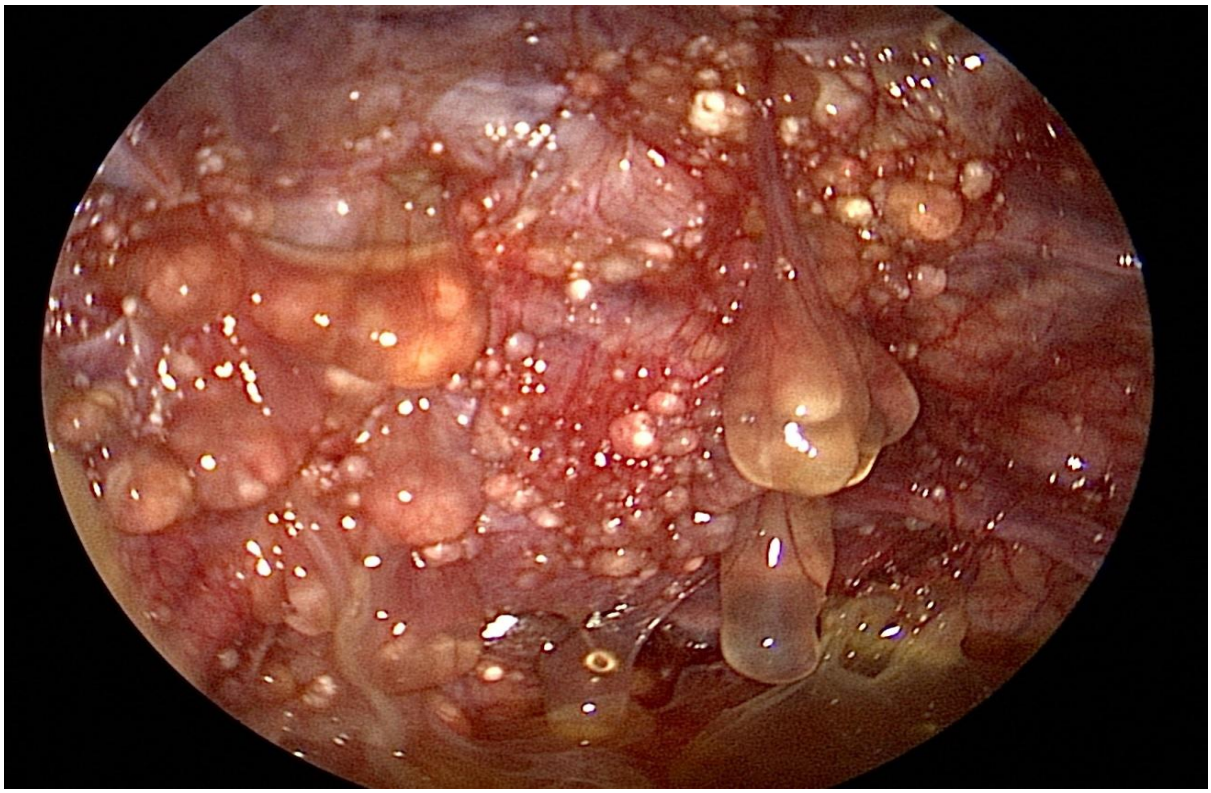
Picture.2 Cyst dissemination at third laparoscopy prior to ultrasound vaporization



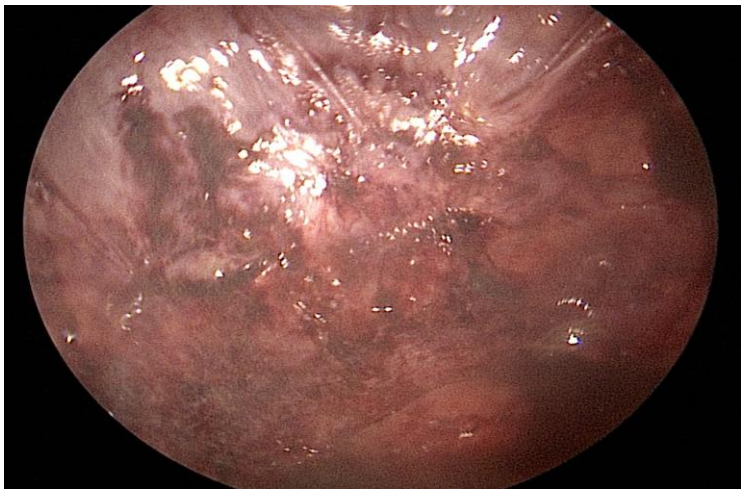
Picture.3 The same situs after ultrasound vaporization



Picture.4 At the fourth laparoscopy, cysts had re - emerged but in smaller quality and quantity. No adhesions had formed at the points of previous ultrasound vaporization.



Picture.5 The same situs of the fourth laparoscopy after ultrasound vaporization, all visible cysts were destroyed with little to none damage on surrounding structures



In conclusion, the present case is noteworthy for highlighting the advantages the CUSA system can provide for benign cystic peritoneal mesothelioma. Given the invasive nature of the current procedures with life-changing consequences, such as infertility and premature menopause, and the mostly ignored consequential long term drawbacks and side effects, such as adhesions formation, we advocate a conservative rather than radical approach with continuous monitoring and optional additional laparoscopic surgery using the CUSA system.

Authors´ contributions

We confirm that the first draft was written by Lasse Leicher and Luz Angela Torres-de la Roche. The manuscript has been reviewed many times and finally approved by all named authors.

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