

Laparoscopic two-steps ovariohysterectomy in five mares with chronic pyometra

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Summary: Equine ovariohysterectomy (OHE) is an uncommonly performed and technically challenging surgery, associated with a high degree of invasiveness, morbidity and high risks of life-threatening complications. The traditional open surgical approach for ovariohysterectomy via post-umbilical laparotomy showed various disadvantages related to limited intraoperative visualization, longer duration of general anaesthesia and high post-operative morbidity. The aim of this study is to report surgical technique and clinical outcome of five mares with chronic pyometra operated with a two-steps surgical procedure, consisting of standing laparoscopy followed by postumbilical ventral midline laparotomy under general anaesthesia. Clinical signs, diagnosis, duration of condition, surgical technique, post-operative period and outcome were reviewed from medical records of five mares that underwent OHE at the Department of Equine Surgery at the Clinic for Horses of the Justus-Liebig-University in Giessen from 2011 to 2019. The indication for ovariohysterectomy was chronic pyometra (n = 5). The surgical technique allowed tension-free dissection and haemostasis of mesovarium and mesometrium by direct visualization during laparoscopy. Despite the fact that the surgery is a moderated technical procedure, no intraoperative complications occurred in any of the patients. Furthermore, all five mares did not develop any serious postoperative complications and survived to discharge. The surgical treatment led to complete resolution of clinical signs in all mares. The laparoscopic two-steps surgery combines the advantages of laparoscopy with the conventional surgical technique and it is nowadays the preferred method for total or subtotal OHE.

Keywords: mare, ovariohysterectomy, laparoscopy, pyometra, minimally invasive

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Introduction

Ovariohysterectomy in mares is an unusually performed and technically challenging surgery, connected with a high degree of invasiveness, morbidity and high risks of life-threatening complications (Santschi et al. 1995). This infrequent surgical procedure is indicated for conditions such as chronic pyometra that does not respond to medical treatment, uterine neoplasia, extensive uterine damage and rupture, chronic uterine torsion and segmental aplasia with accumulation of secretions (Rötting et al. 2003, Doyle et al. 2002). Traditionally, OHE was performed via postumbilical midline celiotomy with the horse in dorsal recumbency under general anaesthesia (Santschi et al. 1995, Rötting et al. 2003, Slone et al. 1988). Undesirable life threatening complications have been reported if the surgery is performed entirely via caudal laparotomy. Reported disadvantages of this approach were poor intraoperative visibility and exposure of planes of dissection, complications derived from large incisions and excessive postoperative morbidity (Woodford et al. 2014). Fatal complications included haemorrhage after surgery, septic peritonitis and colic (Woodford et al. 2014, Santschi and Slone 1994, Torbec 1980). A recent advance in human surgery has been the hand-assisted laparoscopic surgery (HALS), a technique where the surgeon's hand can be inserted into the laparoscopic field while maintaining laparoscopic observation (Wolf

2001, McGinnis et al. 2001). Likewise, equine OHE can be also performed using HALS technique conducted under general anaesthesia in spite of extensive total anaesthesia time (Delling et al. 2004). Another surgical treatment option for pyometra in mares with transluminal cervical adhesions is the cervical wedge resection (Arnold et al. 2015). If this is unsuccessful, OHE is indicated (Woodie 2018). Conservatively, the use of a cervical stent after mechanic dilation of the cervix has been also successfully performed with a good long-term outcome for the treatment of pyometra in three mares (Krohn et al. 2019). A laparoscopic-assisted ovariohysterectomy has been already described with a good intraoperative feasibility and excellent outcome, showing various advantages regarding previous reported techniques (Woodford et al. 2014, Röcken 2013). More recently, unilateral left flank laparoscopic assisted two-step OHE has been successfully performed in a Quarter horse mare (Kadic and Bonilla 2019).

This report describes the surgical treatment, complications and outcome of mares that underwent ovariohysterectomy in our clinic. The aim of this study is to add to the literature and complement with our clinical experience the laparoscopic two-steps procedure.

We hypothesized that the laparoscopic-assisted OHE is an effective treatment to resolve chronic pyometra, it might be re-

lated to less postoperative complications and carries a better prognosis than conventional techniques.

Materials and methods

Medical records of mares that underwent OHE at the Department of Equine Surgery at the Clinic for Horses of the Justus-Liebig-University in Giessen from 2011 to 2019 were reviewed, as well as data of other mares operated in other hospitals. Data examined included patient details, clinical signs, diagnosis, duration of condition, surgical technique and surgeon, post operative medication, complications and outcome. Follow-up informations were obtained by telephone call to owners.

Results

Five client-owned mares underwent surgery during this period in the university hospital. Chronic pyometra was diagnosed in all mares either by the referring veterinarian or at the Clinic for Obstetrics, Gynecology and Andrology of Large and Small Animals of the Justus-Liebig-University in Giessen. The diagnosis was confirmed by ultrasonography, vaginal examination and transrectal palpation before surgery. Patient information and clinical data are summarized in Table 1. Duration of clinical symptoms associated to pyometra ranged between 0.5–3 years. All the mares were treated by the same surgeon (MR).

Besides that, nine mares were operated by the previous surgeon in other hospitals, but not sufficient clinical data was available to include precise information in the next sections. Indications for surgery of these mares were pyometra ($n = 6$), chronic endometritis with uterine adhesions ($n = 2$) and uterine tumor ($n = 1$). Surgical procedure was performed without complications and all patients were discharged from the hospital. Data regarding follow-up was not available.

Surgery

To resolve this condition, all five mares underwent a two-steps OHE procedure, consisting of standing laparoscopy followed by a laparotomy under general anesthesia. After the first clinical exam, feeding was modified by reducing the amount of roughage, and introducing a soft diet for 3 days. Feed was withheld for 18 hours preoperatively with free access to water. In order to decrease volume of fluid and bacterial load in Mares 2, 3, 4 and 5, uterine fluid was removed and the uterus was irrigated with 0.9% NaCl two times a day during the previous days of surgery. Flunixin meglumine (1.1 mg/kg bwt intravenously [IV]) was administered preoperatively in all mares. In addition, antibiotic therapy was selected upon preoperative microbiology and susceptibility test of uterine samples and consisted on cefquinome (1 mg/kg bwt IV) (Mare 1, 3 and 4), gentamicin (6.6 mg/kg bwt IV) and amoxicillin (10 mg/kg bwt IV) (Mare 2) or marbofloxacin (2 mg/kg bwt IV) (Mare 5). The horses were restrained in standing stocks and sedated with an initial bolus of detomidine (0.01 mg/kg bwt IV) and butorphanol (0.02 mg/kg bwt IV). Sedation was maintained with supplementary doses of detomidine (2 µg/kg bwt IV) and butorphanol (2 µg/kg bwt IV) to effect. A transrectal examination was performed to confirm absence of

Table 1 Patient details and clinical data | Patientenangaben und klinische Daten

Breed	Mare n°	Age (years)	Diagnosis	History	Duration (years)	Post operative complications	Long term outcome
Warmblood	1	15	Chronic pyometra	Mild weight loss, purulent vaginal discharge	2	No postoperative complications. Discharge 8 days after surgery	Complete resolution of clinical signs.
Appaloosa	2	16	Chronic pyometra	Infertility. Severe filling and enlargement of the uterus. Uterine wall was mildly edematized	3	Depression, anorexia. Mild colic signs (4 days after surgery) Incisional infection. Discharge 15 days after surgery. Relapse of vaginal discharge 28 days after surgery.	Complete resolution of clinical signs.
Warmblood	3	23	Chronic pyometra	Filled uterus and enlargement of the right uterus horn.	Unknown	4/5 left hind limb lameness after recovery. Discharge 5 days after surgery	Complete resolution of clinical signs. The mare gained weight
Paint horse	4	15	Chronic pyometra	Purulent vaginal discharge. Enlargement of the uterus	0.5	No postoperative complications. Discharge 6 days after surgery. Fever 3 days after discharge from hospital.	Complete resolution of clinical signs.
Irish Cob	5	22	Chronic pyometra	Mucous vaginal discharge. Enlargement and overfilling of the uterus	1	Depression, anorexia, reduced peristalsis, fever. Uterine stump infection Discharge 18 days after surgery	Complete resolution of clinical signs.

bowel at the site of the laparoscopic portals. After aseptic surgical preparation of both flanks and infiltration of local anesthesia (20 mL of 2% mepivacaine hydrochloride each portal site), the first laparoscopic portal was created in the left flank, midway between the ventral aspect of the tuber coxae and the 18th rib. A 10 mm cannula with a blunt obturator was used to penetrate the peritoneum and a 57 cm long telescope was inserted into the abdomen. The abdominal cavity was distended with carbon dioxide up to 10–15 mmHg. A second portal was created for the telescope in the 17th intercostal space at the level of the ventral aspect of the tuber coxae. A third portal was placed 8 cm ventral to the first portal in the flank. The 3 cannulas had a rubber valve at their proximal end so that positive pressure could be maintained within the abdominal cavity during the surgery.

After exposure of the ovary and left uterine horn, infiltration anesthesia of the mesovarium, and mesometrium was performed using 20 mL of 2% lidocaine for each structure. Dissection and secure hemostasis of the mesovarium and mesometrium was achieved using a vessel-sealing system (LigaSureR[®] Force Triad[™], Tyco Healthcare Deutschland GmbH, Soltau, Germany), with a 10 mm Ligasure Atlas[™] forceps of 37 cm shaft inserted through portal 3 under laparoscopic control. The mesometrium was transected in a cranial to caudal direction, trying to reach the caudal end of the body of the uterus. Care was taken to dissect the mesometrium as close as possible to the mesometrial junction and not to injure the ureter (Figure 1).

After complete dissection, the abdomen was inspected for any signs of haemorrhage. All instruments and cannulas were removed and all incisions were routinely closed in two layers (external abdominal oblique muscle outer sheath and skin) using USP 1 and USP 2-0 polyglactin 910, respectively. The procedure was then performed on the right side in the same fashion. No intraabdominal bleeding occurred during the dissection in any patient.

Immediately after the standing procedure, general anaesthesia was induced with ketamine (2.5 mg/kg bwt IV) and diazepam (0.05 mg/kg bwt IV) and the patient was placed in dorsal recumbency in neutral position. Anesthesia was

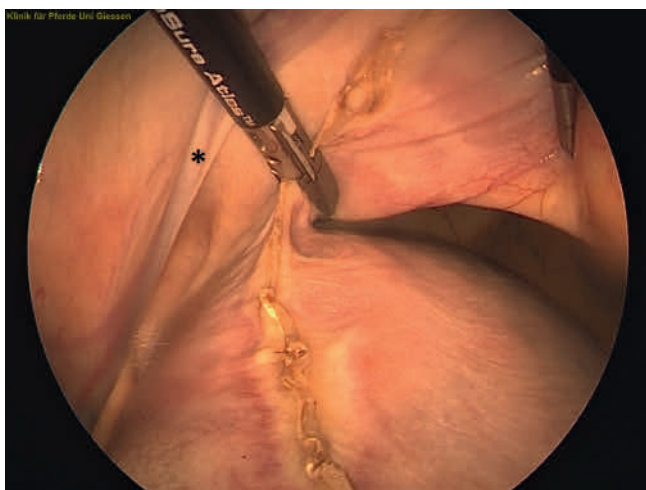


Fig. 1 Laparoscopic view demonstrating the dissection of the mesometrium. Note the tensed left lateral ligament of the bladder (asterisk). | *Laparoskopisches Bild des präparierten Mesometriums. Beachten Sie das angespannte linke Blasenband (*).*

maintained with isoflurane in oxygen. A postumbilical ventral midline celiotomy of approximately 12–14 cm was performed and extended caudally up to the udder level. The genital tract was then exteriorized manually (Figure 2). In Mare 3 further dissection of the mesometrium was continued with Ligasure at this point in order to be able to exteriorize a larger segment of uterine body. If any fluid remained in the uterus, this was massaged towards the horns. Afterwards, the uterine body was clamped with a Mikulicz intestinal clamp forceps as far caudally as possible and with a Doyen bowel clamp placed 3 cm cranially. The uterus was sharply transected between the two instruments and care was taken to avoid any leakage from the lumen by placing a saline-soaked laparotomy sponge dorsal to the uterine transection line. Enough tension to avoid uterus retraction to the abdomen was maintained using uterus grasping forceps and stay sutures. The uterine stump was sutured using a two-layer continuous Cushing with USP 0 polyglactin 910 (Figure 3). The surgical incision was closed routinely in



Fig. 2 Exteriorization of the genital tract during postumbilical midline laparotomy (caudal is down in the image). | *Vorlagerung des Genitaltrakts während der postumbilicalen medianen Laparotomie (kaudal ist unten im Bild).*



Fig. 3 The uterine stump has been sutured. Note the left and right laterally placed stay sutures to permit last evaluation of the stump before repositioning it into the abdomen. | *Der Uterusstumpf wurde vernäht. Beachten Sie die seitlich platzierten Haltefäden, die eine letzte Beurteilung des Stumpfes ermöglichen.*

four layers (peritoneum, linea alba, subcutaneous tissue and skin). General anesthesia time ranged between 70–110 min, while surgery was 55–90 min. Total surgical time including both procedures was between 150–195 minutes. All patients recovered uneventfully from general anesthesia.

Post operative care

After surgery, all patients received intravenous maintenance fluid therapy (2 ml/kg/h Ringer's lactate) and lidocainhydrochlorid (0.05 mg/kg/min DTI) for 24 h. Mare 3 developed a hind limb lameness after recovery, which resolved spontaneously one day after. The mares were offered soft food and hay in a restricted amount for the first 24 hours, followed by hay ad libitum.

Antibiotic therapy with cefquinome (1 mg/kg bwt IV, q24 h) was continued in Mares 1, 3 and 4 for 5 days. Mare 2 received gentamicin (6.6 mg/kg bwt IV, q24 h) and amoxicillin (10 mg/kg bwt q12 h IV) for a total of 7 days. However, trimethoprim-sulfadimethoxin (30 mg/kg bwt PO, q12 h) was started two days later because of pyrexia and it was continued for 7 days. Mare 5 received marbofloxacin (2 mg/kg bwt IV) for a total of 13 days.

Duration of anti-inflammatory therapy was decided according to clinical evolution postoperatively and ranged from 4 to 14 days. Mares 1 and 3 received flunixin meglumine (1.1 mg/kg bwt IV, q12 h) for 3 days and the doses were halved on the fourth day, one day later it was stopped. Mare 4 received flunixin meglumine (1.1 mg/kg bwt IV, q12 h) for 4 days and halved the next day. The Mare 2 received flunixin meglumine (1.1 mg/kg bwt IV, q12 h) for 6 days and it was halved the following day. Administration 2 days later was restarted and continued for 6 days because of colic symptoms and fever. Mare 5 received flunixin meglumine (1.1 mg/kg bwt IV, q12 h) for 14 days and halved the next day.

The hospitalization period ranged between 5–18 days after surgery. Mare 1 and 4 did not experience any complication postoperatively and were discharged on day 8 and 6 respectively. Likewise, Mare 3 was discharged on day 5. Mare 2 experienced mild depression, anorexia and colic signs 4 days postoperatively that resolved with anti-inflammatory therapy. Moreover, this patient developed moderate incisional infection and stayed in hospital until infection was under control (day 15). This mare was readmitted 28 days after surgery due to relapse of purulent vaginal discharge. The uterine stump was lavaged with 0.9% NaCl two times daily for 5 days until vaginal discharge resolved. Mare 4 developed fever three days after discharge from hospital. Although no cause of fever was found by the veterinarian at home, it resolved with antibiotic therapy alone. Mare 5 developed decreased borborygmi, anorexia, depression and fever 24–72 h after surgery. It had a recurrent fever episode on day 7 with a drop of white blood cells ($2.7 \text{ cell} \times 10^9/\text{L}$). Transrectal sonographic examination and palpation via vagina was consistent with infection of the uterine stump. The patient was placed additionally on preventive metronidazole (25 mg/kg bwt PO, q12 h) from day 7 after surgery until microbiology results from uterine secretions were available. Microbiology contained *Streptococcus equi* subsp.

zoepidemicus and susceptibility test revealed the pathogen was intermediate resistant to marbofloxacin. According to the susceptibility results, the horse was then placed (day 13 post OP) on trimethoprim-sulphadiazine (30 mg/kg bwt PO, q12 h) for 14 days. The cervix was partially sealed and only permitted flushing with a foal-size nasogastric tube. The mare responded favourably to local treatment and systemic antibiotic therapy and was discharged on day 18 after surgery.

Follow-up

Information over 12 months was available and obtained by phone interview with the owners in all of the cases. It revealed that these mares recovered without major complications after discharge from the hospital, had total resolution of clinical signs and went back to the intended use, mainly recreational.

Discussion

In this report we described the technique and the favourable outcome for mares treated with a two-steps OHE with laparoscopic assistance. The two-steps principle has been already used by the authors for either ovariohysterectomy (Röcken 2013) or ovariectomy for those cases in which the ovary was too enlarged to be exteriorized through the flank (Röcken et al. 2011).

Technically, the laparoscopic-assisted ovariohysterectomy gives various advantages in relation to the conventional surgical procedures. The poor exposition and blind dissection during laparotomy in the conventional technique was reported as the main limitation. This is largely improved with the new technique, since the normal anatomic position of viscera in the standing horse eases to find dorsal location of the planes of dissection.

During haemostasis, the dissection line in the mesometrium was performed as close as possible to the mesometrial border for three reasons. Firstly, the mesometrium is thinner in its mesometrial junction than in more dorsal planes, easing and speeding up the transection procedure. Secondly, smaller vessels originating from the uterine artery are encountered more ventral, thus minimising the risk of intra or postoperative bleeding. Lastly, to avoid iatrogenic damage of the ureter in the caudal aspect of the broad ligament. Caudally, the ureter is located approximately 4–5 cm dorsal to the mesometrial-uterine junction (MR, unpublished observations). Therefore, the dissection line must be less than 4 cm dorsal to this border. Moreover, the vessel-sealing system provided a good intraoperative haemostasis, especially for the ovarian and uterine artery and no intraoperative or postoperative haemorrhage occurred in any of these cases. In the case of bleeding during laparoscopy, especially from major vessels, haemorrhage could be controlled under visual supervision using either the Ligasure, staples, endoclips or an extracorporeal knot if needed.

Two cases within the group of mares operated in another clinic presented uterine adhesions with the small colon. Although the trigger mechanisms of adhesion formation remain unclear, possible causes are ischemia, surgical trauma, in-

flammation, haemorrhage, thermal or chemical injury, genetic predisposition and reactions to foreign bodies (de Moura et al. 2014). Chronic inflammation of the endometrium could probably have triggered adhesion formation in these two particular cases. Adhesiolysis during laparoscopy was performed in these two cases using the Ligasure system. This permitted the direct exteriorization of the genital tract during the second procedure without impediments and, consequently, a reduction of surgical and anesthetic time. Therefore, laparoscopy can also be useful to diagnose and treat adhesions in cases of chronic pyometra within the context of an OHE. Even though, no adhesions were present in the five mares of our study.

In previous reports, the amount of dissection of the mesometrium during standing laparoscopy was limited and often ended at the junction between the uterine horns and the body (Gablehouse et al. 2009, Santschi 2014). A recent case report described for the first time the dissection of the broad ligament up to the caudal end of the body of the uterus via laparoscopy. The main novelty of the previous work is performing the laparoscopic dissection through a single left flank approach (Kadic and Bonilla 2019). Similarly, but using a left and right laparoscopic approach we were able to reach this point of dissection in four mares. This was not possible in Mare 3 because of limited exposure.

The biphasic technique permits a considerable reduction of the anesthetic risk derived from the general anaesthesia during the second part of the procedure. As seen in this case series, the total anaesthesia time can be decreased considerably. Besides, potential cardiorespiratory negative effects derived from placing the horse in Trendelenburg position with the hindquarters elevated 15° can be avoided (Rötting et al. 2003), since the major dissection is previously done, and other viscera do not represent a problem to exteriorize the dissected genital tract. The surgical time was 150 to 210 minutes when laparoscopy was performed using a HALS technique under general anaesthesia (Delling et al. 2004). In the previous study, one mare was euthanatized after a bilateral femur fracture during anaesthetic recovery (Delling et al. 2004). Except for the lameness of Mare 3, probably associated to the recovery phase, either the rest of the mares of this study or the other mares operated in other hospitals did not experience problems during anaesthetic recovery. We hypothesise that reduction of the total anaesthesia time may favour better recoveries. Moreover, this technique permits the reduction in the length of the laparotomy incision, as its length only needs to permit the manual exteriorization of the genital tract. In this regard, the incisions in this study were not longer than 12–14 cm, compared to 35–40 cm previously reported (Rötting et al. 2003). Although there was a case of incisional infection in our study, probably related to contamination during surgery or recovery, a smaller incision may enhance the healing of the wound and reduce the convalescence period.

All mares operated on survived to discharge from hospital and had a complete resolution of clinical signs. In conclusion, the laparoscopic two-steps surgery combines the advantages of laparoscopy with the conventional surgical technique, and so it might be the preferred method for total or subtotal ovariohysterectomy.

Conflict of interest

The authors declare no conflict of interest related to this report.

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