KIDNEY EXTRACTION
- THREE LAPAROSCOPIC TECHNIQUES IN PORCINE MODEL

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Abstract

The aim of this study was to compare the effectiveness and safety of three laparoscopic techniques of kidney extraction - minilaparotomy, mechanical morcellation, and manual morcellation, in experimental transperitoneal laparoscopic nephrectomy in pigs. Laparoscopic surgery was performed in 12 pigs with body weight ranging from 20 to 30 kg. After two months of observation, post-mortem examinations revealed differences in the formation of peritoneal adhesions in three animal groups. This experimental part of the study should help optimising similar techniques in dogs.

Key words: pig, laparoscopy, nephrectomy, morcellation, peritoneal adhesions.

Minimally invasive surgical techniques are becoming increasingly popular in veterinary clinical practice. The advantage of many laparoscopic procedures over conventional methods encourages the expansion of the scope of surgery involving this technique. Classic laparotomic nephrectomy involves a high tissue traumatisation. It receives coverage in veterinary source (2), but there is a lack of publications discussing optional methods of organ evacuation. In human medicine, a variety of techniques and devices have been developed for kidney entrapment and retrieval. However, no consensus on the best method has been established, and the choice usually depends on the surgeon and unproven factors (1, 5).

The aim of this study was to compare the effectiveness and safety of three different laparoscopic techniques used in renal retrieval from the peritoneal cavity in experimental transperitoneal laparoscopic nephrectomy in pigs. The results of the study will serve to determine the optimal method of kidney extraction in canine laparoscopic surgery because swine anatomy and body size is similar to that of dogs.

Material and Methods

In the course of the study, 12 Polish Large White breed pigs of both sexes, aged around two months, and weighing 20-30 kg were subjected to transperitoneal laparoscopic nephrectomy. The animals were divided into three groups according to their sex, vessel ligation method, and applied transperitoneal nephrectomy technique:

- group I: left and right transperitoneal nephrectomy with manual ligation of renal vessels, with the use of surgical suture and renal extraction from the peritoneal cavity by minilaparotomy using an extraction bag (two males and two females);

- group II: left and right transperitoneal nephrectomy with mechanical ligation of renal vessels using titanium clips, and renal extraction from the peritoneal cavity by mechanical morcellation in extraction bag (two males and two females);

- group III: left and right transperitoneal nephrectomy with mechanical ligation of renal vessels using linear stapling devices, and renal extraction from the peritoneal cavity by manual morcellation in extraction bag (two males and two females).

The animals were given no feed for 12 h before the surgery and had no access to water for 8 h before the premedication. The pigs were premedicated with intramuscular injections of 0.5 mg/kg b.w. of Atropinum sulfuricum (Polfa, Poland) and 3 mg/kg b.w of azaperone (Stresnil, Jansen Animal Health BVBA, Germany). General anaesthesia was induced with a 2.5% thiobarbiturate solution (Tiopental-Biochemie, Germany) at a dose of 10-15 mg/kg b.w., IV. Anesthesia was maintained with 1%-1.5% halothane (Narcotan-Lečiva, Czech Republic). The anaesthetised animals were prepared like for classic laparotomy. The patients
were positioned and affixed in dorsal recumbency. Pneumoperitoneum was created and laparoscopic ports were inserted. The 10 mm optical port was placed paramedianly, around 5 cm lateral of the linea alba at the level of L2-L3 lumbar vertebrae on the side of the operated kidney. To facilitate the description of laparoscopic procedures, working ports were numbered from 1 to 3, where No. 1 was assigned to the cranialmost port. A 10 mm working port No. 1 and 5 mm working port No. 2 were inserted in the axillary line to create an equilateral triangle with the optical port. The distance between ports No. 1 and 2 was determined by the animal's size. A 5 mm working port No. 3 was installed in the caudalmost position, at mid-length between the umbilicus and pubic symphysis, along the axillary line. All working ports were situated on the side of the operated kidney. The above description applied to the ports used in all experimental groups. Kidney preparation, renal vessel and ureter ligation procedures are discussed in a separate publication (6).

**Group I.** The ablated kidney was extracted from the peritoneal cavity by minilaparotomy using an extracting bag with a self-expanding ring (Endo Bag Karl Storz, Germany). The extracting bag was introduced into the operative area through working port No. 1. The organ was manipulated using graspers in ports No. 2 and 3, and it was placed in the bag lumen. The wound of port No. 3 was expanded by incision to create operative access, approximately 3 to 4 cm in length. The free end of the bag ring was grasped with the grasper in port No. 1. Then it was moved to the wound area where it was handled with Pean forceps. The ring was pulled to close the bag and support kidney extraction. Port and minilaparotomy wounds were closed with layered sutures.

**Group II.** The ablated kidney was extracted from the peritoneal cavity after mechanical morcellation using an extraction bag with a self-expanding ring. Similarly as in group I, the extracting bag was introduced into the operative area through working port No. 1. The kidney was placed inside the bag lumen using graspers in ports No. 2 and 3. A grasper was inserted in port No. 1, it was used to grasp and retract the free end of the bag with the sac mouth, and the entire port was removed. A laparoscope with a view angle of 0° was replaced with a 30° angle device. The morcellator arm with the grasper was introduced into the bag lumen (Karl Storz model Rotocut G1, Germany). Morcellation was performed under video control, strips of renal tissue were extracted and the procedure was completed by removing the bag with the organ fragments and the collected fluid. Port wounds were closed with layered sutures in accordance with the standard surgical procedure.

**Group III.** The ablated kidney was extracted from the peritoneal cavity after manual morcellation using a laparoscopic bag with a self-expanding ring. The extracting bag was introduced into the operative area through working port No. 1. The organ was placed in the bag lumen using graspers in ports No. 2 and 3. A grasper inserted in port No. 3, was used to retract the bag mouth, and the entire port was removed. A laparoscope with a view angle of 0° was replaced with a 30° angle device. Swab-holding forceps were inserted inside the bag lumen, and the kidney was morcellated by crushing and extracting tissue fragments. The bag with the organ fragments and the collected fluid was removed. Port wounds were closed with layered sutures in accordance with the standard surgical procedure.

Bag tightness was tested post-operatively in all groups by filling with physiological saline. All of the examined bags were tight and marked by intact stretch. Post-operative observations were continued for two months during which the pig body weight increased to 50-60 kg. Euthanasia was carried out using pentobarbital (Morbital-Biowet, Poland) after premedication with azaperone (Stresnil, Jansen Animal Health BVBA, Germany).

### Results

Anaesthetic and intraoperative complications were not observed in any of the 12 pigs subjected to laparoscopic nephrectomy. Pathological symptoms were not noted during eight weeks of postoperative observations. Respiratory rates, pulse rates, and body temperature, monitored every 2 d for 2 weeks, were within the physiological norm. Forty-eight hours after the procedure, feed intake levels were identical to those before the surgery in all pigs. Laparoscopic wounds healed without complications with minimal inflammatory reactions.

In all patients, a post-mortem examination revealed peritoneal adhesions between the visceral peritoneum of the colon, loose fragments of parietal peritoneum and psoas muscles at the nephrectomy site. The observed adhesions had a width of 1.5 to 3.5 cm and a length of 4 to 5.5 cm. Peritoneal adhesions between the visceral peritoneum of the small intestine and the parietal peritoneum at the site of the minilaparotomy wound were also observed in all animals of group I.

### Discussion

**Group I.** According to the authors, the use of a extracting bag significantly facilitated kidney extraction. The holder assembly for introducing the bag into the peritoneal cavity supported easy insertion through the trocar sleeve. A rigid, self-expanding ring facilitated the placement of the kidney in the bag lumen without traumatising the organ's parenchyma, thus minimising the risk of iatrogenic dissemination of possible neoplastic cells. The kidney was easily manipulated inside the laparoscopic site, which facilitated its extraction through a relatively small minilaparotomy wound. The organ was completely isolated from the integuments, which, according to Kaouk and Gill (5), prevents the dissemination of neoplastic cells in the minilaparotomy wound.

**Group II.** The morcellation procedure was impeded by increased intra-abdominal pressure, which caused the laparoscopic bag to cling to the kidney. The
attempts to lower intra-abdominal pressure led to a collapse of the integuments, which restricted the visualisation of the procedure to the extent that its further execution became unsafe. Due to the absence of a working area, there was a risk of damage to the extracting bag with the morcellator's rotating blade. Publications in the area of human medicine (3, 7) describe cases of iatrogenic damage to the bag with the blade of a mechanical morcellator. According to Kaouk and Gill (5), extraction bag perforation could lead to the dissemination of possible neoplastic cells. Despite the noted problems, the morcellation procedure described in this study did not lead to damage of the extracting bag. The morcellator arm activates the rotating blade only under pressure, which is exerted when the kidney is pulled with graspers. The above solution additionally minimised the risk of accidental damage to the extracting bag.

Organ morcellation facilitated its extraction through the wound with an approximate length of 10 mm. Similarly to some human medicine researchers (1, 7, 10), the authors are of the opinion that the elimination of minilaparotomy through the use of morcellation reduces post-operative pain and post-operative analgesia requirements, and produces better cosmetic effects. The opponents of morcellation (5, 9) point to the possibility of post-operative complications, including iatrogenic bowel damage, liquid discharge from the extraction bag, and tumour cell implantation in the laparoscopic port site incision.

In human medical literature, the reliability of a histopathological evaluation of a morcellated organ remains controversial. Most doubts concern kidneys affected by neoplastic changes. Many researchers (4, 8) argue that kidney morcellation obstructs a post-operative histopathological assessment, in particular the evaluation of neoplastic infiltration in the renal capsule, renal vessels, and perirenal tissue. In this study, the kidneys were not affected by pathological changes, and they were suitable for a histopathological assessment after mechanical morcellation.

Contrary to group I, peritoneal adhesions between the peritoneum at the intemumentary incision site and the intestinal visceral peritoneum were not reported in animals of group II. According to the authors, the morcellation and elimination of minilaparotomy minimise the risk of peritoneal adhesions in laparoscopic nephrectomy wounds in pigs. There are no published studies in human medicine comparing the frequency of peritoneal adhesions in transperitoneal laparoscopic nephrectomies involving morcellation and minilaparotomy.

**Group III.** Similarly as in group II, increased intra-abdominal pressure caused the extracting bag to cling to the kidney. The morcellation procedure was performed with the use of swab-holding forceps in a manner that prevented damage to the extraction bag within a small operative area. Both forceps arms were imaged prior to the separation of successive kidney fragments, which additionally protected the extraction bag from damage. According to some authors (1, 3), in comparison with mechanical morcellation, the use of manual morcellation diminishes the risk of damage to the extraction bag. In the opinion of the authors, manual morcellation is easier to perform than mechanical morcellation. The cost of popular surgical instruments for manual morcellation is also substantially lower than the cost of mechanical morcellation devices. The extracted tissue samples were fit for a histopathological evaluation. Similarly as in group II, peritoneal adhesions between the peritoneum at the intemumentary incision site and intestinal visceral peritoneum were not noted in group III. Kidney morcellation enables safe kidney retrieval through intemumentary wounds with a length of approximately 1 cm and significantly minimises the risk of post-operative intraperitoneal adhesions.

**References**