UKRAINIAN JOURNAL OF VETERINARY SCIENCES

2024. Volume 15, No. 1. P. 66-83

Received: 26.10.2023 Revised: 26.01.2024 Accepted: 28.02.2024

DOI: 10.31548/veterinary1.2024.66

UDC 636.08:616.55-07

The nature of abdominal surgery for polycystic kidney disease in animals and the role of sonographic indicators at different stages of surgical intervention: A literature review

Igor Dekhnych*
Postgraduate Student
Poltava State Agrarian University
36003, 1/3 Hryhorii Skovoroda Str., Poltava, Ukraine
https://orcid.org/0000-0001-5687-3765

Tamila Zvenihorodska
PhD in Veterinary Sciences
Poltava State Agrarian University
36003, 1/3 Hryhorii Skovoroda Str., Poltava, Ukraine
https://orcid.org/0000-0002-4186-5700

Abstract. Analysis of the method of using sonography during surgery in animals with polycystic kidney disease is an urgent task since firstly, sonography is a safe and non-invasive method of examination, which allows determining the structural features of the kidneys before, during, and after surgery. Secondly, from the standpoint of improving the results of surgery, sonography helps to clarify the localisation of cysts and determine their size. Thirdly, an important factor in the use of sonography is the reduction of pain and the risk of postoperative complications. In addition, due to this method of kidney examination, it is possible to more accurately determine the optimal route of access to cysts, which helps to reduce tissue injury and ensures rapid recovery of the animal after surgery. The purpose of the study is to analyse in detail and describe the method of using sonography during surgery in animals with polycystic kidney disease. The study focuses on the need to determine how sonography affects reducing the duration of surgery, improving the quality of cyst removal, and reducing the risk of complications during abdominal surgery. The approach in this study is based on the analysis of scientific papers on this subject, in particular on the experience of veterinarians who have already used sonography during abdominal operations

Suggested Citation:
Dekhnych, I., & Zvenihorodska, T. (2024). The nature of abdominal surgery for polycystic kidney disease in animals and the role of sonographic indicators at different stages of surgical intervention: A literature review. *Ukrainian Journal of Veterinary Sciences*, 15(1), 66-83. doi: 10.31548/veterinary1.2024.66.

*Corresponding author

Copyright © The Author(s). This is an open access article distributed under the terms of the Creative Commons Attribution License 4.0 (https://creativecommons.org/licenses/by/4.0/)

in animals with polycystic kidney disease. Thus, special techniques of sonography and surgical treatment of kidney cysts include dopplerography, colour dopplerography, 3D and 4D sonography, elastography, introperative sonography, intraperitoneal sonography, and duplex scanning of renal arteries and veins. Surgical methods of treatment include extraction of individual cysts, drainage of cysts, resection, and nephrectomy. The use of sonography at different stages of surgical intervention helps to optimise the operation process, reduce the risk of complications, and contribute to the introduction of new approaches in the treatment of animals with polycystic kidney disease, which will substantially improve their quality of life

Keywords: veterinary medicine; organ degeneration; epithelial cells; diagnostics; abdominal cavity; minimally invasive surgery

Introduction

According to F. Perondi *et al.* (2020), the problem of polycystic kidney disease is important in the field of veterinary medicine, as its prevalence in animals is increasing. This is a challenge for veterinary specialists and requires the development of effective treatment and diagnosis methods. The importance of the problem lies in the fact that polycystic kidney disease can lead to the development of kidney failure and other serious complications.

Scientific studies on polycystic kidney disease in animals are conducted in different countries of the world. Sonography is one of the most effective methods for diagnosing polycystic kidney disease, which allows accurately determining the size, shape, and number of cysts on the surface of the kidneys. Most research on polycystic kidney disease in animals has focused on the use of sonography to diagnose and monitor kidney health during treatment. Some of them focus on analysing the results of sonography and its impact on the results of surgery, while other studies determine the effectiveness of minimally invasive surgical methods for treating animals with polycystic kidney disease. The results of the analysis of current studies of Ukrainian researchers in the context of polycystic kidney disease in animals reflect the focus of research on determining effective methods for the diagnosis and treatment of this disease. Thus, N.J. Patel *et al.* (2020) indicate the importance of sonography for determining the prevalence and monitoring the dynamics of polycystic fibrosis. The results of their study show that sonography is an important tool in the diagnosis and monitoring of kidney disease in animals with this pathology. The study of L. Schirrer *et al.* (2021) highlights the main aspects of diagnosis and approaches to treating polycystic fibrosis. Researchers emphasise the importance of timely diagnosis and choosing the optimal treatment plan, considering the age and individual characteristics of the patient. K. Debruyn *et al.* (2012) describe current methods for the diagnosis and treatment of polycystic kidney disease, mentioning sonography and focusing on the importance of early detection and thorough examination of patients to choose the optimal treatment strategy.

Studies on the effectiveness of sonography during abdominal surgery for polycystic kidney disease in animals have shown that this method is reliable and helps reduce the risk of complications during its implementation. One such recent study was conducted by B. Dekerle *et al.* (2022), analysing data from a 10-month-old dog the sonography of which accurately determined the location of a cyst in the

kidney. Subsequently, the cyst was drained by ultrasound monitoring, performed before and during surgery. The study showed that sonography helped to more accurately determine the size and location of the cyst on the surface of the kidney, which contributed to its effective removal during surgery. In addition, sonography during surgery was identified to determine the presence of additional cysts and complications, such as bleeding. The same conclusion was reached in the studies by F. Rossi *et al.* (2023), which describe the use of computed tomography and sonography to detect cysts on the kidney surface in dogs and cats with polycystic kidney disease. The researchers noted that sonography is a highly sensitive method for diagnosing the presence of cysts in the kidneys, which helps determine the degree of prevalence of the disease and decide whether to perform surgery.

A study published by C. Thanaboonnipat *et al.* (2020) examines the use of elastography (a type of sonography) in the examination of kidneys in animals. Research has shown that elastography can be useful in assessing the texture of kidney tissue and help identify kidney cancer. Other studies focus on the use of 3D and 4D sonography to determine the shape and size of cysts on the kidney surface in animals, including in real-time. For example, Y. Huang *et al.* (2021) showed the use of 3D sonography to assess the size and shape of cysts on the kidney surface in dogs with acute abdominal haemorrhage. It was established that 3D sonography can be useful for assessing the relationship of cysts with nearby organs and structures. Authors investigated the use of sonography in kidney screening and reducing invasiveness. As a result, it was argued that "sonography can be a promising imaging diagnostic tool for assessing kidney condition". Studies on the effectiveness of sonography during abdominal surgery for polycystic kidney disease in animals show that sonography is an integral part of surgical practice for such patients.

This review paper is based on an analysis of various sources and methods, including PubMed, Google Scholar, and other databases, for obtaining scientific publications, monographs, dissertations, and scientific conference reports on polycystic kidney disease in animals. The information obtained was processed, summarised, and evaluated in the context of surgical treatment. By comparative analysis of various methods of diagnosis and treatment of polycystic kidney disease, the most effective approach was identified. The results of previous studies and publications, including data from well-known specialists related to the surgical treatment of animals with this disease, were reviewed. The data obtained helped determine the best approaches for the diagnosis and treatment of animals with polycystic kidney disease and also confirmed the validity of using sonography in the surgical treatment of this pathology.

The purpose of the study is to analyse scientific sources regarding the nature of abdominal surgery for polycystic kidney disease in animals and the role of sonographic indicators at different stages of surgical intervention. This will lead to the enrichment of scientific knowledge, solving the problem of polycystic kidney disease in animals, and improving the practice of surgical intervention in this case. Tasks include: analysis of scientific papers covering the problem of polycystic kidney disease in animals and the nature of abdominal surgery in this case; determination of the role of sonography as a diagnostic method for polycystic kidney disease in animals; establishing a relationship between sonography indicators and surgical intervention results; evaluating the effectiveness of using sonography at different stages of abdominal surgery for polycystic kidney disease in animals.

Methods of treatment of polycystic kidney disease in animals and basic tools

Abdominal surgery for polycystic kidney disease in animals can be performed using various methods depending on the size and number of cysts on the surface of the kidneys and requires great care and precision on the part of the veterinary surgeon since cysts can be very thin-walled and easily torn during surgery. According to the data of I.S. Dekhnych *et al.* (2021), this may lead to the development of complications.

The studies of N.J. Patel *et al.* (2020) and B. Dekerle *et al.* (2022) indicate that abdominal surgery for polycystic kidney disease in animals can include several stages: preparation of the animal for the operation: keeping it on a starvation diet for 12-24 hours before the operation, improving the level of hygiene and additional studies, such as clinical blood tests and sonography; anaesthesia of the animal: before the operation, the animal is subjected to anaesthesia, which ensures a painless condition during its implementation and helps to reduce the risk of complications. Instruments and tools are also prepared for the operation, as various methods can be applied to the operation, such as sterilisation of the operating area and preparation of proper equipment for its implementation. After preparing the operating area, the animal is given a lying position on its side with a positional sonography lens to clarify the location of cysts and kidneys; then, an incision is made, and muscle and fascial tissues are separated to provide access to the kidneys. Once access to the kidneys is achieved, cysts are removed, which can include various methods, such as removing cysts with special tools or cutting them into smaller pieces that can be removed with minimal damage to the surrounding tissue. After that, the final stage of the operation takes place.

J. Park *et al.* (2019) argue that after opening the abdominal cavity and examining the kidneys, the surgeon can continue to compare the presence of cysts with a preliminary sonographic assessment. If a cyst is found that obscures the image, the surgeon can confirm its location and size using dopplerography and elastography. In addition, additional sonographic studies, such as colour dopplerography and 3D/4D sonography, can be performed to assess the relationship of cysts with surrounding organs and structures.

X. Zhang *et al.* (2020) in their paper note that after evaluating the results of the sonographic examination, the surgeon can apply various treatment methods:

- (extraction) of individual cysts: the surgeon removes the cyst from the kidney using a special tool;
- cyst drainage: the surgeon inserts a thin hose through the kidney cyst and applies drainage to remove fluid from the cysts;
- kidney resection (partial removal): the surgeon can perform resection of the part of the kidney where the cysts are located;
- nephrectomy (complete removal) of the kidney: if the cysts are located in the area of the renal branches, the surgeon performs a nephrectomy – complete removal of the kidney.

After removing cysts that could cause complications, according to E. Stock *et al.* (2018), a final examination of the kidneys and surrounding tissues is performed to detect other abnormalities or complications. After removing the cysts and performing drainage, the surgeon should check all operated vessels for bleeding and ensure their hemostasis. Then, the condition of the kidneys is evaluated and it is identified whether they are working well. Special tests are usually performed to do this, for example, diuresis and blood creatinine levels are measured. If the operation is successful and no complications occur, the sick animal can be sent to the hospital for postoperative observation or allowed to be taken home, provided

that certain instructions and recommendations for care are followed. Notably, polycystic kidney disease is a chronic disease, so postoperative care and regular medical examinations by a veterinarian are necessary to monitor the functional state of the kidneys and prevent relapses of the disease.

During surgery for polycystic kidney disease in animals, a variety of tools are used to remove cysts. The main tools, according to Y. Bayazit *et al*. (2003), include:

♦ endograbler or "rake", which has very thin forceps with a hook at the end, enabling the collection and removal of small cysts from the kidneys;

♦ endoclipper or "scissors", equipped with two blades, which are usually located at the end of a flexible shaft, and designed for cutting cysts;

♦ an endodrill or "crushing drill" is used to remove large cysts, which is supplemented with a crushing head that can rotate at high speed, allowing the cysts to be crushed;

♦ an endoscope is a small device consisting of a thin tube with a camera at the end that is inserted into the body through a small incision in the skin and used to examine the surgical field and monitor the process of removing cysts;

♦ laparoscope – allows the surgeon to perform surgery through small incisions in the skin using a camera located at the end of a thin tube.

The surgeon selects instruments based on the size and location of the cysts, and the functional ability of the kidneys and the general health of the animal. It is essential to choose the right tools and techniques to reduce the risk of complications and maximise kidney function. According to K. Debruyn *et al*. (2012), the role of sonography during surgery for polycystic kidney disease in animals depends on the type of instrument used during surgery. When using traditional tools such as scissors, tweezers, and curettes, sonography can be helpful in determining the location of cysts and tracking the process of removing them. Additionally, sonography allows tracking the degree of violation of the structure of tissues during surgery.

When using endoscopic control instruments, such as laparoscopes and robotic systems, as noted by F. Rossi *et al.* (2023), sonography can be used to map the internal structure of kidney organs and cysts with high resolution. This can help reduce the risk of damage to surrounding tissues and organs during surgery. Abdominal surgery for polycystic kidney disease in animals is a serious medical intervention that should only be performed by qualified veterinary surgeons with experience in such operations. The animal should be prepared in detail for the operation, including a preliminary assessment of its health status, performing various laboratory and instrumental studies to ensure safety during the operation.

Postoperative animal care is also quite important. After the operation, the animal should be placed in a special room where it can recover under the supervision of veterinary specialists. The animal must receive sufficient food and water and the necessary amount of medicine. Signs of possible postoperative complications, such as bleeding, infections, or other health problems must be carefully monitored.

Methods of sonographic research, disadvantages of using sonography in polycystic kidney disease in animals and evaluation of the effectiveness of using sonography

C. Thanaboonnipat *et al.* (2020) note in their paper that sonographic examination is a painless and non-invasive method that plays an essential role at various stages of abdominal surgery in the case of polycystic kidney disease in animals. Sonography allows estimating the size and number of cysts that may be present in the animal's kidneys. Before starting the operation,

sonography helps the veterinary surgeon plan the course of the operation, choosing the safest technique for removing cysts from the animal's kidneys. In addition, this method can be used to assess the extent of damage to the kidneys and other internal organs, which can help the veterinary surgeon determine the complexity of the operation (Fig. 1).

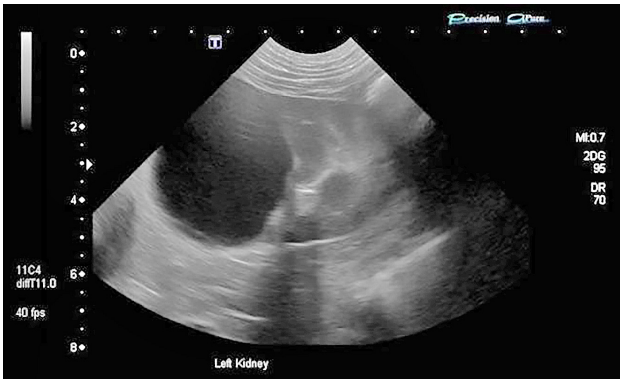

Figure 1. Ultrasound image along the long axis of the left kidney of an 8.8-year-old, 41.9 kg, neutered male, mixed breed with a diagnosis of intra-renal cystic lesion
***Sourse**: M. Vagias (2022)*

The method of the study consists in placing the patient on the operating table so that the cyst under study is available for scanning from different angles. The study should be conducted in B-mode, which allows getting a two-dimensional image of the object, as stated by L. Meomartino *et al.* (2021). According to N. Bilgen *et al.* (2020), to determine the size of the cyst, images are made in two projections: vertical and horizontal. Scanning from different angles, changing the position of the sensor is conducted to do this. The image measures the distance between opposite points on the periphery of the cyst. Y. Hwang *et al.* (2020) note that for a more accurate assessment of the cyst size, it is necessary to make several measurements in different projections and calculate the average value.

It is important to get images in different projections to assess the shape of the cyst. Visualisation of the cyst in a profile projection allows you to estimate its shape and length-to-width ratio. As studies by K.R. Waller *et al.* (2007) show, to determine the relationship of cysts with surrounding organs and structures, sonographic studies using various scanning modes are applied. Commonly used modes are B-mode, M-mode, and colour dopplerography. The patient should be positioned on its back to determine the relationship of the cyst with the kidneys and ureters. Firstly, the kidneys are examined and their size and shape are determined. Then, with the help of an angular sonda, examinations are performed at different levels of the kidneys and ureters. M.M. Larson *et al.* (2021) note that during this study, it is important to determine the presence of cysts in the kidneys and ureters and to determine whether cysts are able to compress or interfere with the normal flow of urine.

G. Kumar (2012) indicate that B-mode and colour dopplerography are used to determine the relationship of cysts with the abdominal cavity and individual internal organs. Firstly,

the abdominal cavity is examined to determine the presence of cysts and their location. I. Matos *et al.* (2018) report that individual internal organs and structures should then be examined using various sondas to elucidate existing relationships with cysts. According to W.M. Thaiss *et al.* (2019), in some cases, additional examinations may be required, such as computed tomography (Fig. 2) or magnetic resonance imaging, for more detailed information about the relationship of cysts with surrounding organs and structures.

Figure 2. Transverse (a), sagittal (b), and dorsal (c) conventional computed tomography multiplanar reconstructions of images of the same dog diagnosed with a kidney cyst
***Notes**: numerous non-contrasting, well-defined ovoid structures of various sizes and fluid attenuation are visible in the cortical and medulla of both kidneys. The caudal pole of the right kidney contains a very large, egg-shaped, thin-walled, non-contrasting reinforcing fluid weakening structure that has replaced the normal architecture of its caudal third. In Figures (a) and (c), the left side of the dog is to the right of the images*
***Sourse**: M. Vagias (2022)*

According to C.A. McAloney *et al.* (2018), special techniques are used to determine the location of a cyst during sonographic examination. One of them is the "cross-scanning" or "perpendicular scanning" technique. It consists in the fact that the sonography device is placed parallel to the surface of the animal's body, and the probe is placed perpendicular to it in the direction that needs to be examined. During cross-scanning, the probe is placed on the animal's skin where the examination is required, and scans are performed from different angles. This allows getting more detailed information about the location of the cyst, its size, and shape.

In addition, as noted by K. Debruyn *et al.* (2012), the "real-time scanning" or "two-way scanning" technique can be used to determine the location of the cyst. In this case, the probe is placed on the animal's skin at the point that needs to be examined, and scans are performed in real-time. During the scan, not only the cyst tissue but also the surrounding space is visualised, which allows getting more detailed information about the location of the cyst, as confirmed by W.R. Widmer *et al*. (2004). A. Agut *et al.* (2020) note that in any case, to determine the topography of cyst placement, it is necessary to conduct a study in different planes, using dif-

ferent scanning techniques to get the most complete information about its size, shape, and location. During surgery, especially in organs with a rich network of blood vessels, the possibility of bleeding is a severe risk. Sonography can be useful for identifying possible sources of bleeding and estimating its volume.

In their study, L. Schirrer *et al.* (2021) note that sonography can assess the structure of tissues, which helps to identify possible bleeding sites, in particular, the separation of bleeding vessels from non-bleeding tissues, the detection of narrowing or dilation of blood vessels, and the identification of possible changes in the shape and size of organs. In addition, using colour and pulse dopplerography, the speed of blood flow in the vessels can be determined, which can help identify pathological changes in blood circulation. If a bleeding area is detected during surgery, the doctor may take the necessary measures to stop the bleeding, such as ligation or blood coagulation. Sonography can help during these procedures by providing visualisation of bleeding vessels and helping the doctor choose the most effective method to stop the bleeding.

After surgery, a sonographic examination can be used to monitor the condition of the animal's kidneys and evaluate the effectiveness of the treatment. It allows the veterinary surgeon to determine how completely cysts were removed from the animal's kidneys and assess the condition of the kidneys and surrounding tissues after surgery. D.J.X. Liu *et al.* (2019) claim that sonographic examination can be performed during surgery using a portable device with an ultrasound head. High-frequency ultrasound heads with a frequency of 7.5 to 12 MHz are usually used to ensure optimal visualisation of the kidneys during surgery.

According to the study by M.M. Larson *et al.* (2021), sonography techniques during surgery may vary depending on the type of surgery and the location of cysts in the animal's kidneys. However, the general approach to performing sonography includes the following steps. Preparation of the patient when the animal is subjected to general anaesthesia and placed on the operating table. Preparation of the device head and sonography (the ultrasound head is sterilised and applied to the animal's skin in the kidney area). Communication with the device is provided by means of a gel. The operating team receives an image of the kidneys on the device screen. Monitoring the operation with sonography: during the operation, the veterinary surgeon determines the exact location of the cysts and the degree of their interaction with the kidneys, noted M. Bertolotto *et al.* (2018). It also monitors the condition of the kidneys and other internal organs to detect possible complications during surgery. After surgery, a veterinary surgeon may perform additional sonography to assess the condition of the kidneys and other internal organs.

Based on the resulting images, as noted by I.C.K. Cruz *et al.* (2021), the doctor evaluates the condition of the kidneys, their shape, size, number, and size of cysts. If the kidneys appear substantially enlarged, with a large number of cysts, complications may occur during surgery, such as bleeding, impaired kidney function, and damage to surrounding organs. Therefore, P.G.S. Cardoso *et al*. (2019) indicate that it is important to accurately determine the size and number of cysts and the location of the kidneys before starting surgery. For this purpose, special sonography techniques can be used, such as dynamic sonography, which allows visualising changes in the size and shape of the kidneys during the animal's movements and various phases of breathing. 3D and 4D sonography can also be used, which allows getting a more detailed image of the structure of the kidneys and cysts.

When performing sonography during surgery, it is important, according to D.J.X. Liu *et*

al. (2019), to ensure the safety of the animal. Therefore, it is fixed in a soft fabric that prevents movement. In addition, special gels can be used to improve the connection between the sonograph sensor and the animal's skin, which improves image quality.

Although sonography is a useful tool for diagnosing and determining the location of cysts on the surface of the kidneys during abdominal surgery for polycystic kidney disease in animals, it has some disadvantages. F. Rossi *et al.* (2023) stated in their paper that sonography might be less effective if the kidneys are far from the surface of the skin, if there are thick layers of muscle and adipose tissue between them and the sensor that interfere with visualisation, or when the presence of air structures in the stomach or intestines reduces the effectiveness of sonography. This method can also provide only limited information about the internal structure of cysts, such as the presence of internal partitions or stones. As noted by S. Griffin (2020), sonography may be less effective in diagnosing smaller cysts because they tend to be less visible in the image. There may be cases when this method does not provide sufficient information to decide on the type of surgery and may require additional studies, such as computed tomography or magnetic resonance imaging. However, given these shortcomings, sonography is still a valuable tool for surgical intervention in polycystic kidney disease in animals. B. Vázquez & J. Daniel (2021) argues that in the case of non-standard situations, veterinarians combine sonography with other diagnostic methods, such as radiography, computed tomography, magnetic resonance imaging, etc., to obtain maximum information about the condition of the animal's kidneys and determine the optimal treatment tactics. The author's assessment of the use of sonography at different stages of abdominal surgery for polycystic kidney disease in animals indicates its effectiveness, informative value, and prospects. Thus, it was found that sonography allows getting a detailed three-dimensional image of the kidneys and other internal organs during surgery. This improves the ability to accurately locate and evaluate kidney cysts and provides real-time visualisation of blood circulation and blood flow (International renal..., n.d.).

In the early stages of surgery, when the question of the possibility of resection or extraction of cysts is decided, sonography provides the possibility of accurate diagnosis and assessment of the size of cysts, which contributes to more precise planning of surgical actions. In addition, during the operation itself, intraoperative sonography provides an opportunity to monitor the process of cyst removal, drainage, and other manipulations in real time. The data obtained confirm that the use of sonography allows the veterinary surgeon to perform accurate and safe operations, minimising the risk of possible complications. An important aspect is also to reduce the invasiveness of surgery due to the possibility of intraperitoneal sonography, which allows obtaining diagnostic information without interfering with the renal parenchyma (Frazier & Huppmann, 2020).

Thus, the results of the study confirm that sonography is an integral and effective component of abdominal surgery for polycystic kidney disease in animals, providing accurate diagnosis, greater controllability of surgical procedures, and improved treatment outcomes.

Special sonography techniques: Dopplerography, colour dopplerography, 3D and 4D sonography, elastography, intraperitoneal sonography, duplex scanning of renal arteries and veins

In cases where the animal's kidneys have a complex structure or in the presence of complications during the development of polycystic

kidney disease, M.M. Larson *et al.* (2021) indicate that special sonography techniques may be involved:

♦ dopplerography – used to assess blood circulation in the kidneys, which allows identifying possible problems with blood flow, such as narrowing of the arteries, which can cause complications during surgery;

♦ colour dopplerography – used to determine the direction and speed of blood flow in the kidneys, which allows the veterinary surgeon to assess the condition of the kidneys in more detail and identify possible circulatory problems;

♦ 3D and 4D sonography – necessary for obtaining a three-dimensional image of the kidneys and other internal organs, allowing the veterinary surgeon to determine the size and shape of the kidneys in more detail and can be helpful when planning surgery;

♦ elastography – used to determine the density and stiffness of tissues, which can be useful in determining possible complications during surgery and helps the veterinary surgeon more accurately determine the condition of the kidneys;

♦ intraperitoneal sonography – allows getting images of organs in real time during surgery, which requires the use of a special probe that is connected to the sonograph and inserted into the animal's body through a small injection;

♦ intraperitoneal sonography – provides an image of the kidneys and parotid space without interfering with the parenchyma of the organ;

♦ duplex scanning of renal arteries and veins – allows assessing the degree of nodular damage and determine the possibility of preserving the renal parenchyma during surgery.

M. Vagias *et al.* (2022) noted in their paper that the following steps are used to perform intraoperative sonography during abdominal surgery for polycystic kidney disease in animals. An incision of the muscles and anterior abdominal wall is performed to access the abdominal cavity. A miniature probe is used, which is inserted into the abdominal cavity to do this. The next step is to perform a sonography of cysts to determine the location of the kidneys. The number of cysts that affect the size of the kidneys is assessed, and the number of polyps and their size located in the kidney cavity is estimated. Then, the size and condition of the kidneys are evaluated using a high-frequency probe, and colour Doppler sonography is used to examine the blood supply to the kidneys. In the next step, the renal arteries and veins are examined to determine their size and diameter. At the end, the cysts are punctured to examine their contents.

Based on the result of Y. Huang *et al.* (2022), the method of dopplerography for abdominal surgery for polycystic kidney disease in animals consists of the following steps. Preparation of the animal: the animal is subjected to general anaesthesia and fixed in the optimal position for the examination. Coat of the animal in the examination area should be trimmed and cleaned of various types of dirt. It is important to ensure the thermal comfort of the animal during the operation. Installation of the dopplerographic sensor on the surface of the animal's skin: before starting the examination, the sensor is lubricated with gel to ensure better contact with the surface of the animal's skin and better transmission of sound waves. Determination of test parameters: the doctor determines the test parameters, such as the signal penetration depth and sensor frequency. This allows obtaining the most accurate results. Image acquisition and analysis of results: a dopplerographic sensor is moved along the vessel to obtain an image of blood flow. After finding the appropriate blood vessels, dopplerography is performed to measure the blood flow rate. The image is transmitted to the monitor, where the doctor analyses the results. F. Freccero *et*

al. (2020) emphasise that the data obtained on the rate of blood flow in the arteries and veins help to assess the condition of the kidneys, diagnose the presence of bleeding, and determine the level of blood flow in the organs.

For example, the rate of blood flow in the renal artery can help assess the perfusion (patency) of the kidneys, that is, how fully the blood flow supplies the kidneys with oxygen and nutrients. If perfusion is impaired, problems with kidney function may occur. The blood flow rate in the renal vein can also indicate the degree of blood drainage (outflow) from the kidneys. A decrease in the rate of blood flow in the renal vein indicates impaired drainage and blood retention in the kidneys. The rate of blood flow in the renal artery is usually in the range of 80 to 180 cm/s. Therewith, a decrease in blood flow rate to 70 cm/s or less may be a consequence of impaired renal perfusion. S.M. McLeland *et al.* (2015) note that the rate of blood flow in the renal vein is usually in the range of 15 to 40 cm/s. A decrease in the blood flow rate to 10 cm/s or less may indicate a violation of blood drainage from the kidneys. Assessment of blood flow rate in arteries and veins using dopplerography is an important component of the diagnosis and treatment of animals with kidney pathology. These data help doctors more accurately assess the condition of the kidneys and plan further treatment tactics.

N.J. Patel *et al.* (2020) noted in their paper that colour dopplerography is a modern method of visualising and examining blood circulation in animal organs. The main method of colour dopplerography for abdominal surgery for polycystic kidney disease in animals is as follows. After opening the abdominal cavity, the researcher finds the animal's kidneys and discovers the blood vessels that supply these organs. Next, the device is configured for colour dopplerography, and optimal scanning parameters are determined. After that, the researcher begins scanning the arteries and veins that feed the kidneys using colour dopplerography. During the scan, the doctor receives an image of blood vessels with a colour-coded blood flow rate. This allows estimating the speed of blood flow in the arteries and veins and determining the direction of blood flow. The data on the speed of blood flow in the arteries and veins allowed assessing the condition of the kidneys and deciding on further actions during surgery. After completing the examination, the data obtained are analysed and the results are recorded. Colour dopplerography allows analysing not only the speed of blood flow in arteries and veins but also determining the size and structure of blood vessels, which is vital in the diagnosis and treatment of polycystic kidney disease in animals (Fig. 3).

J. Park *et al.* (2019) note that the optimal scanning parameters for colour dopplerography may vary depending on the specific situation and the scanning technique used by the doctor. However, in general, the following parameters are recommended: the frequency corresponds to the range between 2 and 5 Mhz, depending on the depth at which the examination is to be conducted; the flow rate is usually adjusted to the maximum value that can be measured during the study; angular correction: the angle adjustment between the direction of blood flow and the direction of the ultrasound wave, which affects the accuracy of measuring the flow rate; acoustic power should be adjusted to a safe level. The scan settings may change during the study, depending on what is displayed on the screen. Optimal scanning parameters should provide a high-quality and accurate image to assess the condition of the kidneys and blood circulation.

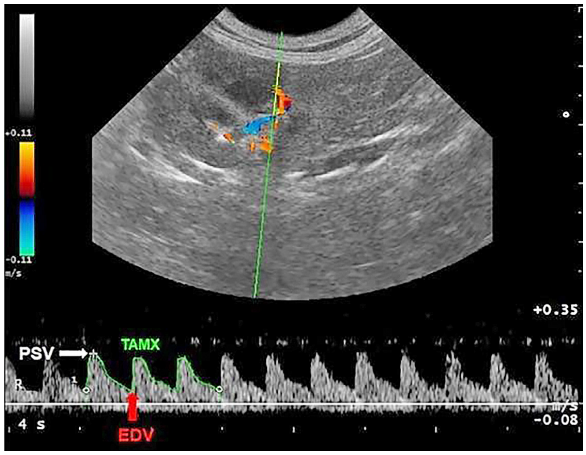

Figure 3. Colour dopplerography of the kidneys
***Notes**: measurement of resistivity index (RI) and pulsation index (PI) in the intrathecal artery. Doppler wave showing the difference for peak systolic velocity (PSV), end-diastolic velocity (EDV), and time averaged maximum velocity (TAMX)*
***Sourse**: study by G.C. Evangelista et al. (2023)*

During dopplerography, based on the results of the studies by K.R. Waller *et al.* (2007), it was established that the following parameters should be used to estimate the blood flow rate in arteries and veins. Peak Systolic Velocity (PSV) is the maximum blood flow rate in an artery during the systolic phase of the cardiac cycle. End Diastolic Velocity (EDV) – the rate of blood flow in an artery during the diastolic phase of the cardiac cycle. Resistive Index (RI) – the ratio of the difference between the maximum and minimum blood flow rate in the artery to the maximum blood flow rate. Pulsatility Index (PI) – the ratio of the difference between the maximum and minimum blood flow rate in an artery to the average blood flow rate. The direction of blood flow is determined using a coloured doppler, which reflects the direction of blood movement in the corresponding vessels (Parolini *et al.*, 2009). Optimal scanning parameters may vary depending on the specific technique and type of doppler equipment. As noted by B. Singh (2018), to accurately assess the blood flow rate and determine the direction of blood flow, it is crucial to follow the recommendations of the manufacturer of doppler equipment and conduct scans under optimal conditions.

3D and 4D sonography are methods that allow obtaining a three-dimensional image of an object. In the case of polycystic kidney disease, 3D and 4D sonography can help determine the size and shape of kidney cysts and the position and location of polyps and cysts. Y. Huang *et al.* (2022) indicate that the methods of 3D and 4D sonography for abdominal surgery for polycystic kidney disease in animals are the same as for conventional sonography. However, to get three-dimensional images, it is necessary to increase the number of cross-sections and change the position of the probe. In the case of 3D sonography, the resulting image can be viewed in different planes, which provides detailed information

about the internal structure of the kidneys. In the case of 4D sonography, the image can be viewed in real-time, which allows assessing the movement and dynamics of the object. Elastography is a method that allows assessing the elasticity of tissues. In abdominal surgery for polycystic kidney disease in animals, elastography can be used to assess the stiffness of renal tissue and detect signs of fibrosis.

M. Vagias *et al.* (2022) argue that the method of performing elastography in abdominal surgery for polycystic kidney disease in animals includes the following steps:

♦ *animal training:* the animal must be under anaesthesia, which will ensure maximum stability during elastography. At the moment, there is no special dietary preparation for elastography;

♦ *conducting elastography*: after standard sonography, elastography is performed, for which an elastography sensor is placed on the surface of the kidney to measure tissue stiffness. When using a device with integrated elastography, sonography usually proceeds immediately to measuring stiffness. The screen displays an image of fabrics, in which the stiffness is shown on a colourful scale. The darker the colour, the softer the fabrics, the lighter – the stiffer;

♦ *data analysis:* after performing elastography, the obtained data can be processed and analysed using special software.

For intraperitoneal sonography, based on the results of C.A. McAloney *et al.* (2018), a special catheter must first be inserted through the terminal intestine into the coccyx area, allowing access to the intraperitoneal cavity. Next, a special elastic hydrogel balloon is placed on top of the catheter, which ensures a tight seal at the entrance to the cavity and prevents fluid from escaping during the study. After that, a sonographic sensor is connected to the catheter, which allows getting an image of the kidneys and parotid space and assessing the size and number of cysts in the kidneys. These techniques reduce the risk of kidney damage during surgery and maximise its effectiveness.

Disadvantages of using sonography for polycystic kidney disease in animals and evaluating the effectiveness of using sonography

Although sonography is a useful tool for diagnosing and determining the location of cysts on the surface of the kidneys during abdominal surgery for polycystic kidney disease in animals, it has some disadvantages. This method can also provide only limited information about the internal structure of cysts, such as the presence of internal partitions or stones. As noted by S. Griffin (2020), sonography may be less effective in diagnosing smaller cysts because they tend to be less visible in the image. There may be cases when this method does not provide sufficient information to decide on the type of surgery and may require additional studies, such as computed tomography or magnetic resonance imaging. However, given these shortcomings, sonography is still a valuable tool for surgical intervention in polycystic kidney disease in animals. B. Vázquez & J. Daniel (2021) argues that in the case of non-standard situations, veterinarians combine sonography with other diagnostic methods, such as radiography, computed tomography, magnetic resonance imaging, etc., to obtain maximum information about the condition of the animal's kidneys and determine the optimal treatment tactics. The author's assessment of the use of sonography at different stages of abdominal surgery for polycystic kidney disease in animals indicates its effectiveness, informative value, and prospects. Thus, it was found that sonography allows getting a detailed three-dimensional image of the kidneys and other internal organs during surgery. This improves the ability to accurately locate and evaluate kidney cysts

and provides real-time visualisation of blood circulation and blood flow.

In the early stages of surgery, when the question of the possibility of resection or extraction of cysts is decided, sonography provides the possibility of accurate diagnosis and assessment of the size of cysts, which contributes to more precise planning of surgical actions. In addition, during the operation itself, intraoperative sonography provides an opportunity to monitor the process of cyst removal, drainage, and other manipulations in real time. The data obtained confirm that the use of sonography allows the veterinary surgeon to perform accurate and safe operations, minimising the risk of possible complications. An important aspect is also to reduce the invasiveness of surgery due to the possibility of intraperitoneal sonography, which allows obtaining diagnostic information without interfering with the renal parenchyma.

Thus, the results of the study confirm that sonography is an integral and effective component of abdominal surgery for polycystic kidney disease in animals, providing accurate diagnosis, greater controllability of surgical procedures, and improved treatment outcomes.

Conclusions

The use of sonography during abdominal surgery for polycystic kidney disease in animals is a valuable tool that reduces the risk of complications and improves the accuracy of the operation. This method reduces the duration of surgery for polycystic kidney disease in animals, as it helps the surgeon to more accurately and quickly determine the location of cysts on the surface of the kidneys and not damage the surrounding tissues during their removal. In addition, using sonography reduces the risk of complications after surgery and increases its effectiveness. However, as indicated in studies, there are some disadvantages to the use of sonography in the case of abdominal surgery. This is primarily due to insufficient wave penetration depth and inefficiency in studying high-density structures, such as cysts. In addition, during the operation, it is not always possible to provide optimal conditions for sonography. Thus, the use of sonography in abdominal surgery for polycystic kidney disease in animals has both advantages and disadvantages. Given these shortcomings, sonography is still an effective tool for surgical intervention in polycystic kidney disease in animals. In general, the examination of the problem of polycystic kidney disease in animals is an urgent and vital task for veterinarians and researchers, which requires further scientific research and improvement of diagnostic and treatment methods.

Prospects for further research include determining the optimal parameters of sonography during abdominal surgery in the case of polycystic kidney disease, such as the size, number, and location of cysts, which is extremely important for such surgical interventions. Further investigation of the relationship between polycystic kidney disease and other animal diseases is necessary to identify possible common causes and develop effective methods of prevention and treatment. In addition, determining the possibility of developing new surgical methods that can reduce the risk of complications and improve the results of surgery, is important. Lastly, exploring the possibility of using new technologies, such as robotic systems, to improve the accuracy and efficiency of surgical intervention for polycystic kidney disease is also required.

Acknowledgements

None.

Conflict of Interest

None.

References

[1] Agut, A., Soler, M., & Fernández-Del Palacio, M.J. (2020). Changes in renal resistive index values in healthy puppies during the first months of life. *Animals*, 10(8), article number 1338. doi: 10.3390/ani10081338.

[2] Bayazit, Y., Soyupak, B., Özdemir, S., Arıdoğan, I.A., Doran, S. (2003). Comparison of laparoscopy and open surgery in the treatment of symptomatic simple renal cysts. *Urology Research & Practice*, 29(3), 324-329.

[3] Bertolotto, M., Bucci, S., Valentino, M., Currò, F., Sachs, C., & Cova, M.A. (2018). Contrast-enhanced ultrasound for characterizing renal masses. *European Journal of Radiology*, 105, 41-48. doi: 10.1016/j.ejrad.2018.05.015.

[4] Bilgen, N., Bişkin Türkmen, M., Çınar Kul, B., Isparta, S., Şen, Y., Akkurt, M.Y., Çıldır, Ö.Ş., & Bars, Z. (2020). Prevalence of PKD1 gene mutation in cats in turkey and pathogenesis of feline polycystic kidney disease. *Journal of Veterinary Diagnostic Investigation*, 32, 549-555. doi: 10.1177/1040638720935433.

[5] Cardoso, P.G.S., Pinto, M.P.R., Moroz, L.R., Fontes, T.N., Santos, R.S., Freitas, J.L., Nogueira, V.A., & Peixoto, T.C. (2019). Dystrophic mineralization in uremic dogs: An update. *Pesquisa Veterinária Brasileira,* 39(11), 889-899. doi: 10.1590/1678-5150-PVB-6250.

[6] da Cruz, I.C.K., Gasser, B., Maronezi, M.C., Uscategui, R.A.R., Feliciano, M.A.R., Padilha-Nakaghi, L.C., Aires, L.P.N., & da Silva, P.D.A. (2021). Applicability of B-mode ultrasonography, ARFI elastography and contrast-enhanced ultrasound in the evaluation of chronic kidney disease in dogs. *Pesquisa Veterinária Brasileira*, 411, 67-85. doi: 10.1590/1678-5150-PVB-6785.

[7] Debruyn, K., Haers, H., Combes, A., Paepe, D., Peremans, K., Vanderperren, K., & Saunders, J.H. (2012). Ultrasonography of the feline kidney: Technique, anatomy and changes associated with disease. *Journal of Feline Medicine and Surgery*, 14(11), 794-803. doi: 10.1177/1098612x12464461.

[8] Dekerle, B., Fabres, V., Benchekroun, G., & Manassero M. (2022). Long-term follow-up of a juvenile simple renal cyst in a dog treated by laparoscopic deroofing, fulguration, and omentalization. *Journal of the American Veterinary Medical Association,* 260(11), 1-5. doi: 10.2460/javma.21.06.0272.

[9] Dekhnych, I.S., Zaviliy, M.F., & Rakitina, A.I. (2021). Diagnostic sonography during abdominal surgery in animals. *Bulletin of the PSAU*, 1, 241-249. doi: 10.31210/visnyk2021.01.30.

[10] Evangelista, G.C., Dornelas, L.R., Cintra, C.C., Valente, F.L., Fajardo, E.S., da Fonseca, L.A., & Reid, E.C.C. (2023). Evaluating feline lower urinary tract disease: Doppler ultrasound of the kidneys. *Journal of Feline Medicine and Surgery,* 25(1), article number 1098612X221145477. doi: 10.1177/1098612X221145477.

[11] Frazier, R.L., & Huppmann, A.R. (2020). Educational case: Autosomal dominant polycystic kidney disease. *Academic Pathology*, 7, article number 2374289520939257. doi: 10.1177%2F2374289520939257.

[12] Freccero, F., Petrucelli, M., Cipone, M., Nocera, I., & Sgorbini, M. (2020). Doppler evaluation of renal resistivity index in healthy conscious horses and donkeys. *PLoS ONE*, 15(2), article number e0228741. doi: 10.1371/journal.pone.0228741.

[13] Griffin, S. (2020). Feline abdominal ultrasonography: What's normal? What's abnormal? The kidneys and perinephric space. *Journal of Feline Medicine and Surgery,* 22(5), 409-427. doi: 10.1177/1098612X20917598.

[14] Huang, Y., Wu, X., Tao, Y. Wu, J., Yang Y., Ma, M., Yuan, X., Li, F., & Hou, X. (2021). *Diagnostic value of doppler ultrasound in early chronic kidney disease*. Retrieved from https://assets.researchsquare.com/files/rs-667000/v1/0dde79c4-eab6-4597-ad00-505cfd7e7b9c.pdf?c=1631885905.

[15] Hwang, Y., Noh, D., Choi, S., Choi, H., Lee, Y., & Lee, K. (2020). Changes of ultrasonographic pattern of the spleen examined with a high-frequency linear transducer during growth in puppies. *Veterinary Radiology & Ultrasound*, 61(5), 577-582. doi: 10.1111/vru.12873.

[16] International renal interest society. IRIS staging of CKD. (n.d.). Retrieved from http://www.iris-kidney.com/guidelines/staging.html.

[17] Kumar, G. (2012). Bilateral superior accessory renal arteries – its embryological basis and surgical importance – a case report. *Journal of Clinical Case Reports*, 2, article number e105. doi: 10.4172/2165-7920.1000e105.

[18] Larson, M.M., Mattoon, J.S., Lawrence, Y., & Sellon, R.K. (2021). Liver. In *Small animal diagnostic ultrasound* (pp. 355-421). Amsterdam: Elsevier. doi: 10.1016/B978-0-323-53337-9.00018-6.

[19] Liu, D.J.X., Hesta, M., Stock, E., Bogaerts, E., Broeckx, B.J.G., Saunders, J.H., & Vanderperren, K. (2019). Renal perfusion parameters measured by contrast-enhanced ultrasound in healthy dogs demonstrate a wide range of variability in the long-term. *Veterinary Radiology and Ultrasound,* 60(2), 201-209. doi: 10.1111/vru.12690.

[20] Matos, I., Azevedo, P., & Carreira, L.M. (2018). Pilot study to evaluate the potential use of the renal resistive index as a preliminary diagnostic tool for chronic kidney disease in cats. *Journal of Feline Medicine and Surgery,* 20(10), 940-947. doi: 10.1177/1098612X17736656.

[21] McAloney, C.A., Sharkey, L.C., Feeney, D.A., Seelig, D.M., Avery, A.C., & Jessen, C.R. (2018). Evaluation of the diagnostic utility of cytologic examination of renal fine-needle aspirates from dogs and the use of ultrasonographic features to inform cytologic diagnosis. *Journal of the American Veterinary Medical Association*, 252(10), 1247-1256. doi: 10.2460/javma.252.10.1247.

[22] McLeland, S.M., Cianciolo, R.E., Duncan, C.G. & Quimby, J.M. (2015). A comparasion of biochemical and histopathologic staging in cats with chronic kidney disease. *Veterinary Pathology*, 52(3), 524-534. doi: 10.1177/0300985814561095.

[23] Meomartino, L., Greco, A., Di Giancamillo, M., Brunetti, A., & Gnudi, G. (2021). Imaging techniques in veterinary medicine. part I: Radiography and ultrasonography. *European Journal of Radiology Open,* 18(8), article number 100382. doi: 10.1016/j.ejro.2021.100382.

[24] Park, J., Moon, C., Lee, M., Lee, H.B., & Jeong S.M. (2019). Surgical fenestration combined with omentalization for the treatment of renal cysts in 2 dogs. *Canadian Veterinary Journal*, 60(10), 1104-1110.

[25] Parolini, C., Noce, A., Staffolani, E., Giarrizzo, G.F., Costanzi, S., & Splendiani, G. (2009). Renal resistive index and long-term outcome in chronic nephropathies. *Radiology*, 252, 888-896. doi: 10.1148/radiol.2523080351.

[26] Patel, N.J., Brady, R., & Scarf, V.F. (2020). Single-incision laparoscopic deroofing and omentalization of a cystic renal adenoma in a dog. *Journal of the American Animal Hospital Association*, 56(6), article number 331. doi: 10.5326/jaaha-ms-6991.

[27] Perondi, F., Lippi, I., Marchetti, V., Bruno, B., Borrelli, A., & Citi, S. (2020). How ultrasound can be useful for staging chronic kidney disease in dogs: Ultrasound findings in 855 cases. *Veterinary Science*, 7(4), article number 147. doi: 10.3390/vetsci7040147.

[28] Rossi, F., Gianni, B., Marconato, L., Sabattini, S., Caleri, E., Mattolini, M., Camosci, V., & Carozzi, G. (2023). Comparison of sonographic and CT findings for the identification of renal nodules in dogs and cats. *Veterinary Radiology and Ultrasound*, 64(3), 439-447. doi: 10.1111/vru.13219.

[29] Schirrer, L., Marin-Garcia, P.J., & Llobat, L. (2021). Feline polycystic kidney disease: An update. *Veterinary Sciences*, 8(11), article number 269. doi: 10.3390%2Fvetsci8110269.

[30] Singh, B. (2018). Dyce, sack, and wensing's textbook of veterinary anatomy. Amsterdam: Elsevier.

[31] Stock, E., Paepe, D., Daminet, S., Vandermeulen, E., Duchateau, L., Saunders, J.H., & Vanderperren, K. (2018). Contrast-enhanced ultrasound examination for the assessment of renal perfusion in cats with chronic kidney disease. *Journal of Veterinary Internal Medicine,* 32(1), 260-266. doi: 10.1111/jvim.14869.

[32] Thaiss, W.M., Bedke, J., Kruck, S., Spira, D., Stenzl, A., Nikolaou, K., Horger, M., & Kaufmann, S. (2019). Can contrast-enhanced ultrasound and acoustic radiation force impulse imaging characterize CT-indeterminate renal masses? A prospective evaluation with histological confirmation. *World Journal of Urology*, 37(7), 1339-1346. doi: 10.1007/s00345-018-2520-3.

[33] Thanaboonnipat, C., Sutayatram, S., Buranakarl, C., & Choisunirachon, N. (2020). Renal ultrasonographic strain elastography and symmetric dimethylarginine (SDMA) in canine and feline chronic kidney disease. *Journal of Veterinary Science*, 82(8), 1104-1112. doi: 10.1292/jvms.19-0496.

[34] Vagias, M., Chanoit, G., Bubenik-Angapen, L., Gibson, E. A., Rooster, H., Singh, A., Scharf, V., Grimes, J., Wallace, M., Kummeling, A., Flanders, J., Evangelou, G., & Mullins, R. (2022). Perioperative characteristics, histologic diagnosis, complications, and outcomes of dogs undergoing percutaneous drainage, sclerotherapy or surgical management of intrarenal cystic lesions: 18 dogs (2004-2021). *BMC Veterinary Research*, 18, article number 233. doi: 10.1186/s12917-022-03327-z.

[35] Vázquez, B., & Daniel, J. (2021). Avances na ecografía transabdominal en vacas de produción láctea. Lugo: Internacional da Universidade de Santiago de Compostela.

[36] Waller, K.R., O'Brien, R.T., & Zagzebski, J.A. (2007). Quantitative contrast ultrasound analysis of renal perfusion in normal dogs. *Veterinary Radiology & Ultrasound*, 48(4), 373-377. doi: 10.1111/j.1740-8261.2007.00259.x.

[37] Widmer, W.R., Biller, D.S., & Adams, L.G. (2004). Ultrasonography of the urinary tract in small animals. *Journal of the American Veterinary Medical Association*, 225(1), 46-54. doi: 10.2460/javma.2004.225.46.

[38] Zhang, X., Cao, D., Han, P., Ren, Zh., Wang, J., & Wei, Q. (2020). Aspiration-sclerotherapy versus laparoscopic de-roofing in the treatment of renal cysts: Which is better? *BMC Nephrology*, 21, article number 193.

Характер абдомінальної операції при полікістозі нирок у тварин та роль показників сонографічного дослідження на різних етапах хірургічного втручання: огляд літератури

Ігор Сергійович Дехнич
Аспірант
Полтавський державний аграрний університет
36003, вул. Григорія Сковороди, 1/3, м. Полтава, Україна
https://orcid.org/0000-0001-5687-3765
Таміла Владиславівна Звенігородська
Кандидат ветеринарних наук
Полтавський державний аграрний університет
36003, вул. Григорія Сковороди, 1/3, м. Полтава, Україна
https://orcid.org/0000-0002-4186-5700

Анотація. Аналіз методики використання сонографії під час хірургічного втручання у тварин із полікістозом нирок є актуальним завданням, оскільки, по-перше, сонографія є безпечним та неінвазивним методом обстеження, що дозволяє визначити структурні особливості нирок перед, під час та після операції. По-друге, з точки зору покращення результатів операції, використання сонографії допомогає уточнити локалізацію кіст та визначити їхні розміри. По-третє, важливим фактором у використанні сонографії є зниження болю та ризику післяопераційних ускладнень. Крім того, завдяки цьому методу дослідження нирок можливо точніше визначати оптимальний шлях доступу до кіст, що сприяє зменшенню травматизації тканин та забезпечує швидке відновлення тварини після операції. Мета дослідження полягала в детальному аналізі та описі методики використання сонографії під час хірургічного втручання у тварин з полікістозом нирок. Дослідження орієнтоване на необхідності визначення, як сонографія впливає на зменшення тривалості операції, поліпшення якості видалення кіст та зниження ризику ускладнень під час проведення абдомінальних операцій. Дослідницький підхід базується на аналізі наукових праць за цією тематикою, зокрема на досвіді ветеринарних лікарів, які вже використовували сонографію під час абдомінальних операцій у тварин із полікістозом нирок. Так, спеціальні техніки сонографії та хірургічного лікування кіст у нирках включають доплерографію, кольорову доплерографію, 3D та 4D сонографію, еластографію, інтроперативну сонографію, інтраперитонеальну сонографію, а також дуплексне сканування ниркових артерій та вен. У хірургічних методах лікування відзначаються екстракція окремих кіст, дренування кіст, резекція, а також нефректомія. Використання сонографії на різних етапах хірургічного втручання допомогає оптимізувати процес операції та знизити ризик виникнення ускладнень, а також сприятиме впровадженню нових підходів у лікуванні тварин з полікістозом нирок, що істотно поліпшить якість їхнього життя

Ключові слова: ветеринарна медицина; переродження органа; епітеліальні клітини; діагностика; черевна порожнина; малоінвазивна хірургія