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Ultrasonography and some biochemical findings after unilateral radical nephrectomy in cats

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Abstract

In veterinary medicine, laparoscopic nephrectomy for dogs and cats has become the most acceptable scientific trend over traditional open surgery as a result of its great benefits. Unilateral nephrectomy would impact some hormonal and ultrasonic features as a sequel or even as a compensatory mechanism. To ensure these expected outcomes, this work has been planned using sixteen local breed adult cats as an experimental model. A baseline sample of blood and sonography examinations were performed prior to surgery, then a complete unilateral laparoscopic excision of the left kidney was achieved for all cats. The assessment following excision was accomplished using ultrasonographic and biochemical results of erythropoietin and vitamin D3 concentrations on days 15, 30, and 60 following excisions. The follow-up examinations proved the safety of the laparoscopic nephrectomy, while ultrasonographic examination showed the presence of a clear and gradual compensatory increase in the size and the measured dimensions of the remaining kidney since the second week after excision until the end of the study in all experimental cats compared with preoperative values. Besides, the biochemical findings of erythropoietin and vitamin D3 values revealed the presence of a significant gradual compensatory increase in their concentrations from the fourth week after excision until the 60 days. In conclusion, unilateral nephrectomy is highly associated with the presence of ultrasonic and biochemical compensatory mechanisms exhibited by the enlargement of the remaining kidney's size and the elevation in erythropoietin and vitamin D3 concentrations.

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Introduction

Since the first documentation of laparoscopic nephrectomy in 1991 by Clayman and his colleagues, it has become the standard adapted procedure for radical removal of the diseased kidney as a result of its beneficial properties, especially the low rate of postoperative complications, the faster recovery and the shorter hospitalization comparable with traditional open surgery (1-3), in addition to reducing of blood loss from the patient (4,5) and less pain after surgery (6,7) and needless for pain-relieving medications after surgery (8-10) besides, the small wound size instead of incising the abdomen (11). Hand-assistant laparoscopic nephrectomy can be achieved using either 3- or 4-port techniques (12). In small animal practice, kidney removal can be adapted with various renal affections such as renal dysplasia, hydronephrosis, ureteral atresia, nephrolithiasis, polycystic kidney disease, idiopathic renal hematuria, hydronephrosis, chronic or unresponsive pyelonephritis and primary renal neoplasia (2), or even when there is severe renal damage due to trauma or infection (13). The kidney is one of the most essential organs within the urinary system, and the whole body performs many significant physiological and homeostasis duties (14). In cats, these yellowish-brown bean-shaped organs lie within the back of the lumber region on each side of the spinal cord (13). Each one of these kidneys has millions of microscopic constructions known as uriniferous tubules that include collective ducts and nephrons. The nephron represents the functional unit of the kidney, achieving the essential renal functions in filtration, excretion, and resorption (15). The kidney's main physiological functions include the excretory role of preserving the persistent volume and electrolyte homeostasis of the environment around the body cells. This homeostatic role is achieved by the elimination of metabolic end substances such as uric acid, urea, creatinine, and excretion of water and electrolytes. Furthermore, the kidney also has multi-endocrine secretory functions represented by the presence of a class of endogenous renal hormones that significantly affect renal hemodynamics, tubular electrolytes, glomerular filtration, and water processing. These hormones comprise erythropoietin, which is responsible for red blood cell synthesis; angiotensin II, renin, prostaglandins, nitric oxide, and bradykinin, which are critical in regulating blood pressure and maintaining hemodynamics; and finally, vitamin D3 or calcitriol that is responsible for bony tissue metabolism (14-17). Each one of these renal hormones performs a significant role within the living body to ensure the normal functioning of the whole body. For example, erythropoietin (EPO), which highly controls red blood cell (RBC) synthesis that in turn preserves the ratio of blood hemoglobin (Hb) stable under ordinary circumstances, is one of the pleiotropic and blood-specific factors that precisely regulate the progenitor and hematopoietic stem cells viability, production, and distinction (18,19). Erythropoietin itself is a glycoprotein hormone that is synthesized within liver tissue in the fetus, but its production is changed into kidney near birth and postnatally when the place of erythropoiesis transports to bone marrow. The kidney EPO-manufacturing cells within the peritubular interstitial of the renal tissue start to secrete and produce about 90% of the circulating systemic EPO, while the other structures in the adult, such as the liver and brain, yield the remaining 10% (20). The erythropoietin displays a dynamic task in the homeostasis of oxygen-carrying ability that could lead to anemia (21). EPO enhances and preserves red blood cell count; besides, it stimulates the growth and distinction of both erythroid and platelet progenitors and the initiation of hemoglobin production in dividing erythrocyte precursors. Subsequently, the elevated erythropoietin excretion can eventually lead to amplified hematocrit, total red blood cell (RBC) counts, and platelet numbers (22,23). Erythropoietin also stimulates neovascularization and angiogenesis, which enhance blood flow and thus act against ischemic-induced lung, liver, and heart injuries (24). On the other hand, vitamin D3 (cholecalciferol) is exceptional because it can be synthesis in the skin from 7-dehydrocholesterol following exposure to the sun, or it can be taken from the diet; however, both forms of vitamin D are inactive and biologically inert do require hydroxylation to be converted into biologically active form and to be an active influencer in mineral metabolism or even in other physiologic functions such as inhibition of tumor cells growth or shield against some immune-mediated diseases. Therefore, vitamin D must be changed to its active formula (1,25(OH)2D), so it is conveyed to liver tissue where it undergoes hydroxylated into D3 (25(OH)D3), Then that 25(OH)D3, the chief circulating formula of vitamin D, is transferred to the proximal renal tubule of the kidney where it hydroxylates again to producing the physiologically active form of vitamin D (1,25(OH)2D3), or ossifying calcitriol which control most, if not all of the biologic impacts of vitamin D3 (25). The ossifying calcitriol is crucial for preserving calcium homeostasis and controlling the growth of new bone as it stimulates intestinal calcium absorption. If vitamin D is not present, only 60% of phosphorus and 10-15% of dietary calcium are absorbed, while its bioavailability improves calcium and phosphorus absorption by 30-40% and 80%, respectively (26). Although the metabolism of bone is a chief action of vitamin D, most body tissues possess vitamin D receptors; thus, it exerts several physiological activities, including anti-apoptosis, anti-inflammation, anti-oxidant and anti-fibrosis, as well as up surging body immune tolerance by obstructing IL-6production and up-regulating regulatory T cells mass. Furthermore, it reduces cell death and necrosis (23). Besides erythroid precursor propagation, angiogenesis, making, and encouragement of cellular maturation. Recent studies have also revealed that vitamin D shortage is related to low Hb levels and amplified resistance response to erythrocyte stimulation agents ESA (23-27). Additionally, vitamin D deeply impacts the existence of red blood cells within the body and the reaction toward cellular stress, as well as its ability to induce ischemic tolerance. Furthermore, vitamin D can decrease macrophage infiltration (23). In addition to the vital role of each of erythropoietin and vitamin D alone within the living body, the interaction between them also has a significant role in other renal and systemic diseases, particularly cardiovascular disease and anemia (28). It has been reported that the united protective impact of vitamin D3 and EPO is of great potential in the optimization of novel approaches for the inhibition and handling of acute kidney injury (AKI) (23-29).

The countless extended roles of the kidney within the whole body, especially its endocrine secretory functions, make the removal of one kidney due to any cause a serious issue that needs assurance from the presence of a sufficient compensatory mechanism of the other remaining kidney that can sustain and accommodate the required renal function. For the sake of animal health and welfare, this project was designed to assess the ability of the rest of the kidney following nephrectomy to sustain, compensate, and even achieve a sufficient normal renal function in cat models through investigating some renal hormonal and ultrasonographic parameters.

Materials and methods

Ethical approve

The whole adapted procedures associated with this work gained the institutional consent of the board associated with animal care and use of the University of Mosul, College of Veterinary Medicine, issued UM.VET.067, dated 17/9/2024.

Animals and Experimental Design

A total of sixteen (N=16) local bread mature cats of both sexes of 12 months±0.75 old with an average weight of 3.5 kg±0.45 kg were acclimatized for seven days before the start of this experiment. All handling and operational protocols utilized for this experimental design were achieved according to the standard ethics of the animal care and use committee. A baseline sample of blood and sonography examinations were performed for all experimental animals before nephrectomy. Later, a complete laparoscopic excision of the left kidney was achieved for the whole animal using a three-portal 10 mm cannula laparoscopic technique. The assessment following excision was achieved using laparoscopic, ultrasonographic, and biochemical results of erythropoietin and vitamin D3 concentrations on days 15, 30, and 60 following kidney removal.

Anesthetic protocol

The cats were fastened before surgery for 12 hours. All operating dealings were accomplished using general anesthesia by an intramuscular blend of 10 mg/kg of Ketamine Hydrochloride (Narketan®-10, Troy Laboratories PTY Limited, Australia) and 1 mg/kg of Xylazine (ILium Xylazil-100, Troy Laboratories PTY Limited, Australia) (30,31).

Surgical procedure of the complete laparoscopic nephrectomy

Skin routine surgical aseptic procedure for the ventral abdominal area from xiphoid to pelvic at the prepubic region was adopted. Cats were positioned in dorsal recumbency at 30° left angle. A three-portal triangle fashion with a 10 mm cannula technique was adapted for laparoscopic (KARL STORZ 264305 20, Germany) nephrectomy of the left kidney (Figure 1). A stab incision of the skin and subcutaneous tissue on the umbilicus was induced to facilitate the insertion of Verses needle to achieve supplementation of CO_2 gas inside the abdominal cavity to gain pneumoperitoneum. During the full surgical technique, a maximum pressure of 8-10 mmHg was continued (32,33). After gaining acceptable distension of the abdominal cavity, the Verses needle was replaced with a 10 mm trocar- cannula that was introduced through the same location as the Verses needle. The insertion was done in a gentle rotary movement to avoid injury to the viscera. The trocar was advanced until loss of resistance was felt, which was withdrawn while the cannula remained in position to insert the telescope into the abdominal cavity. Once the telescope was introduced into the abdominal cavity, exploration of the viscera was done to identify any bleeding or injury that could happened during the insertion of the Verse needle. While the other two extra tool entrances were accomplished in the same manner. The second 5mm portal was made at the left side of the abdomen just behind the first portal and used to insert Babcock forceps for handling the left kidney, Whereas the third 10mm portal was made at the right side of the abdomen just behind the first portal and 5 cm away from the second portal for insertion of artery forceps to dissect the blood vessels and ureter and clips applicator to ligate the vessels. Following freeing the kidney from the surrounding fatty tissue and peritoneum, left renal vein, artery, and ureter were identified and gently holed by the artery forceps, then two titanium clips (12) were applied separately along 3-4 mm on each one of them and finally cutting was done between them using scissors (Figure 2). The residue of the severed tubular remnant and separated tissues were checked for any remaining bleeding using the laparoscope. As soon as it was sure that there was no bleeding, the laparoscope tool and residual cannula were removed. The pressure was cautiously driven to each sideway of the abdominal wall to enable the leakage of the CO_2 gas outside the abdominal cavity. One or two absorbable monofilament stitches were applied to occlude the muscular layer on each portal, and nylon stitches were used to suture the skin.

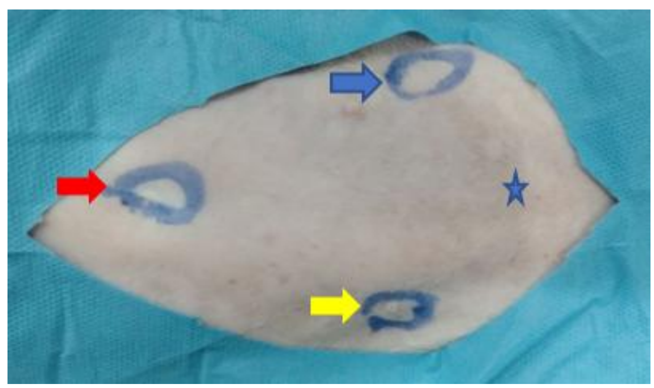

Figure 1: A photographic image of the ventral abdominal wall of the cat shows the three-portal triangle fashion laparoscope approach that was used to perform nephrectomy. The red arrow refers to the first portal incision and to the cranial direction of the animal, the yellow arrow refers to the second portal entrance, the blue arrow refers to the third portal entrance, and the blue star refers to the caudal direction of the animal.

Post-operative care and follow-up

Ultrasonographic inspections of the abdominal cavity and a broad physical investigation were achieved 24 and 72 hours following the procedure to notice any postoperative complications. Penicillin-Streptomycin (kanavet, Canadian), in a dose of 10.0000 IU/kg and 10mg/kg/body weight for three days) were administered. Cats following kidney removal were subjected to daily good exposure to sunlight, while meaty and fishy-rich food was used for their diet.

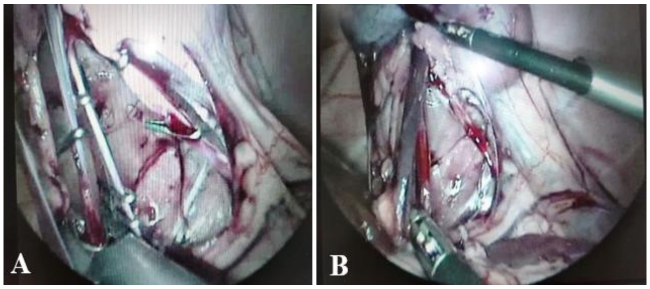

Figure 2: Laparoscopic images show the applied titanium clips over the ureter, renal artery, and renal vein separately (A) and the dissection of the ureter (B).

Biochemical examination

The assessment following kidney excision was achieved based on biochemical values of erythropoietin and vitamin D3 before and after nephrectomy. Blood samples were collected from all experimental animals on the day of operation as a baseline (control) and then at 15, 30, and 60 days postoperatively. The laboratory examination for vitamin D3 was done using Roche Cobas (Switzerland) vitamin D total assay using electrochemiluminescence binding assay, while ELISA DRG international company kit (Spain) was used to estimate erythropoietin. The DRG EPO Immunoassay was a two-site ELISA for the measurement of the biologically active EPO. It utilizes two different monoclonal antibodies. In this assay, calibrators, controls, and cat samples were simultaneously incubated with the enzyme-labeled antibody and a biotin-coupled antibody.

Ultrasonographic assessment

At days 0, 15, 30, and 60 post-excision, assessment evaluation was achieved based on the ultrasonographic data using a convex transducer of 5 MHz of Chison Eco 1 (Chison Medical Technologies Company, China) portable ultrasound machine to detect and measure the three dimensions, i.e., length, width, and thickness of the left kidney.

Statistical analysis

The SPSS (version 22.0) software program was used to analyze the obtained data using One Way ANOVA (analysis of variance) with Duncan's test to measure the significance between different means of periods at $P<0.05$.

Results

Laparoscopic results

Laparoscopic examination of the abdominal cavity on 24 and 72 hours following radical nephrectomy exhibited the absence of any serious intraoperative and postoperative complications, especially blood leakage and loosened occlusion of the remaining renal vessels and ureter stumps.

Biochemical results

The biochemical findings of erythropoietin and vitamin D3 concentrations on days 15, 30, and 60 following unilateral kidney removal revealed the presence of a sharp decline in their rates during the first two weeks following nephrectomy comparable to their rates before excision, but later, there was a gradual compensatory elevation in these values till the end of the experiment. However, that concentration started to elevate on day 30 after surgery and continued rising on day 60 following the operation; however, it did not reach its original baseline level (Table 1). Furthermore, the statistical analysis of erythropoietin concentration displayed a significant difference among these periods. While the value of vitamin D3 at zero-day baseline was 39.5±1.1 ng/mL. Then, 15 days following nephrectomy, there was a significant decline in its ratio. However, that concentration started to increase gradually from day 30 after surgery and kept on rising tile day 60 following the operation; however, it did not range its original baseline values (Table 1). Furthermore, the statistical analysis of vitamin D3 rates displayed a significant difference among these periods.

Ultrasonographic findings

The ultrasonographic findings following unilateral nephrectomy revealed the presence of a gradual compensatory rise in the size and dimensions of the left residual kidney, including its length, width, and especially cortex thickness that started since the second week after excision until the end of the study (Table 2). Furthermore, this enlargement in the remaining kidney reaches up to 30% of its original size. In addition, the sonographic images (Figure 3) showed a clear enlargement in the remaining kidney size in all experimental cats compared with preoperative values.

Table 1: Concentration of serum erythropoietin mU/mL and vitamin D3 ng/mL during the whole period of experimental

Days	0	15	30	60
Erythropoietin (mU/mL)	26.22±2.31 A	18.89±1.67 B	21.30±1.82 A	24.55±1.39 C
Vit. D3 (ng/mL)	39.57±1.11 A	22.14±0.54 B	25.65±0.53 C	36.46±1.01 D

Table 2: The dimensions (cm) of the remaining kidney during the whole period

Days	0	15	30	60
Length	3.43±0.47 A	4.24±.74 B	4.65±0.80 C	4.97±0.59 C
Width	1.87±0.29 A	2.22±0.23 B	2.32±0.24 B	2.48±0.22 C
Cortex thickness	0.35±0.01 A	0.57±0.07 B	0.65±0.06 C	0.70±0.05 C

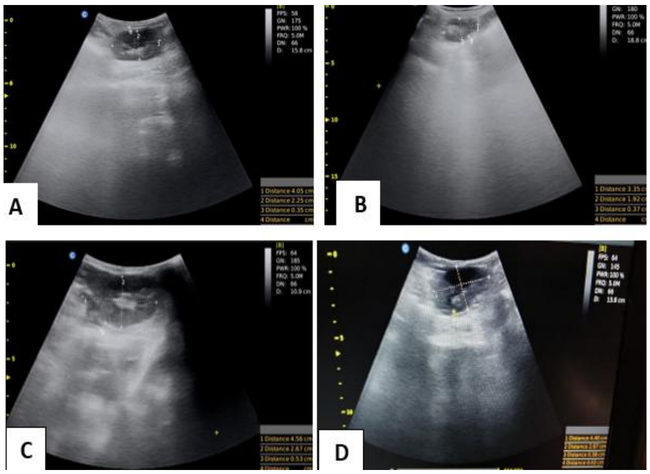

Figure 3: Ultrasonographic images of the remaining kidney showing the differences in its size and the three dimensions on day zero-baseline (A), day 15 (B), day 30 (C), and day 60 (D) following unilateral nephrectomy.

Discussion

The kidney has a substantial role in regulating several systems by performing plenty of excretory and endocrine activities that adjust water and electrolyte values and preserve normal acid-base homeostasis. To be able to carry out all these vital tasks, a number of crucial renal hormones are produced, such as renin, prostaglandins, erythropoietin, and calcitriol (29). These essential physiological duties of kidneys have to continue working during all conditions, especially when there is severe damage that impacts deeply on its whole function, such as trauma, tumor, and infection that needs nephrectomy or even end-stage kidney failure that necessitates kidney transplantation then, the remaining kidney has to maximize its functional abilities up to 70% of the normal function achieved by both kidneys in order to be able to compensate the required necessary renal functional (34).

This study was considered to estimate the capacity of the remaining kidney to sustain and even compensate for the lost renal function following unilateral radical nephrectomy in local breed cats, as it was very crucial to be sure of the true compensatory mechanism that could be adapted by the remaining kidney for the sake of animal health. In this project, a three-portal hand-assisted laparoscopic technique was adopted for unilateral nephrectomy of the left kidney that coincides with Rojas-Canales *et al.* (35) approach who applied the same three ports technique through the umbilical and nearby area for laparoscopic nephrectomy in cats. Our decision to apply laparoscopic nephrectomy instead of traditional open nephrectomy was to get the benefits that are usually associated with applying such a technique, like low morbidity rate, fewer postoperative associated pain, and earlier reoccurrence to normal actions comparable to open nephrectomy; this result was in the same line of *Kim et al.* (12), Alkattan *et al.* (36), Springer *et al.* (37), besides its short operative time, prefect cosmetic outcomes, low-grade complications and finally, its superiority in terms of fewer blood loss, transfusion rate, period of hospital stays and overall complication rate in spite of its associated technical obstacles like high skills training and experience regime needed (38-40).

On the other hand, titanium clips that were used for sealing the ureter and blood vessels proved their efficiency and safety, which was clearly noticeable in the absence of any serious intraoperative and postoperative complications, especially blood leakage. These observations were in the same line as other researchers' findings, Liu *et al.* (41) and Mitthani *et al.* (42), who used titanium clips effectively and safely for closing blood vessels during laparoscopic nephrectomy. Additionally, Ajeel *et al.* (32), Al-Qadhi, and Taha (33) applied these clips successfully for the ligation of ovarian and uterine arteries in dogs or even in rabbits. While Liu and Fan (43) used them during partial laparoscopic splenectomy in dogs. In addition, success in using titanium clips was also documented by other works, especially when using various techniques for laparoscopic castration in dogs (44) or even throughout cystography (45).

The measurements of the remaining kidney's mass and volume following a complete unilateral nephrectomy were considered because it is highly anticipated that there will be an obvious alteration in these dimensions following removal (34) due to the changes happening in the blood flow that will be directed to the remaining kidney instead of both of them. Usually, a single nephrectomy is related to a series of actions in the residual kidney that cause hypertrophy and adaptational alterations, resulting in the extra function of the residual kidney. It is commonly known that about 75% of the increased kidney mass belongs to cell hypertrophy, while cell hyperplasia accounts for the remaining 25%. of kidney enlargement (46,47). The physiological modification of the persistent kidney that accompanies the organizational variations is usually initiated as early as the first two hours following unilateral nephrectomy or even within the first 24 hours next to unilateral radical nephrectomy, and 70% of the preoperative renal clearance was evident within the 7 days next to surgery (48,49).

The ultrasonographic investigations of this work clearly exhibited the presence of gradual elevation in the volume and the whole dimensions of the residual kidney within the whole period of study. This elevation in the kidney's size almost reaches up to 30% of its original size. This observed enlargement of the remaining kidney's mass indicated the presence of an extra function performed by it, as current research has revealed that kidney mass and size are greatly associated with its function, as the elevation in the calculable parenchymal volume and functional performance are greatly associated with renal functional compensation (47,49). The mechanism behind these sequels happens immediately following unilateral nephrectomy as the residual kidney will feel the magnitude of the physiological alterations associated with the excision of the other kidney and react with an equivalent kidney hypertrophy to permit renal hyperfiltration (46,50).

This noticed enlargement of kidney volume following unilateral nephrectomy could be due to the presence of both hemodynamic and tissue structural variations occurred in the reserved kidney as a result of the compensatory deviations in the renal blood flow that became focused on the remaining single kidney instead of both of them (46). Instantly following nephrectomy, direct renal hemodynamic adaptions occur, causing an elevation in active renal hyperfiltration, plasma stream, and glomerular filtration that are related to tubular and glomerular hypertrophy (47). This mechanism of increased kidney volume after unilateral nephrectomy is not the same in the acute versus chronic end stages. Within the acute stage, the kidney size upsurges due to elevated bloodstream, resulting in expansion of the vascular bed, while for the late stage, hypertrophy of renal tissue is the chief reason behind hemodynamic variations. The compensatory expansion in the persistent kidney is steady with the grade of compensatory enlargement of the kidney role. Compensatory kidney growth comprises hyperplasia and hypertrophy of renal tubules and glomeruli. With time elapse, the hypertrophy rate rises while the hyperplasia rate declines (50). Other researchers hypothesized that certain cytokines and growth factors could be responsible for the development of kidney hypertrophy (51). These assumptions about the relation between the kidney volume and its efficient functional ability are further supported by outcome data of other works that noticed that the smaller volume of the harvested kidney was accompanied by deferred kidney function retrieval after donation in spite of other factors (52).

The elevated dimensions of the remaining kidney, which was observed in our work, highly agreed with other researcher's work, Choi *et al.* (50), who noticed that there was an increase in morphology, function, and even hemodynamic parameters at 1 and 12 months following surgery in all living human donors after unilateral nephrectomy, Besides, Chen *et al.* (47) who noticed that in well renal donors, compensatory hypertrophy of the persisted kidney occurred in 79% of the subjects, with an increase in volume of 22% average between 6 months to 1 year next to surgery due to compensatory renal enlargement and improved filtration ability of each glomerulus. The compensation function of the remaining kidney was also trustily mentioned by other multi-institutional studies, which stated that the renal function compensation and glomerular filtration ratio in the preserved kidney following a complete single nephrectomy could be ranging between 16-40% and nearly complete recovery in 45% of patients within 2 years after surgical nephrectomy. This extra compensatory function was highly associated with the rise in the calculable parenchymal size of renal donors that reached up to 25% of the original kidney volume. That increase in its volume was because of the increase in the filtration efficiency of the residual kidney (47). Furtherly, the size and mass of the remaining kidney could be considered as a valuable, dependable parameter for the presence of a well-standing compensatory mechanism, as many authors clearly stated that elevation in the size of the remaining kidney means the presence of a good compensation phenomenon (47-52).

Additionally, the endocrine function of the kidney, especially the values of EPO and vitamin D, were also considered due to their critical roles in various physiological and cellular functions, especially in red blood cell synthesis and bony tissue metabolism (14-17). Besides, it has been reported that vitamin D3 and EPO have valuable synergistic protective impacts in ischemic renal injury via anti-apoptosis and anti-inflammatory pathways (23). Moreover, vitamin D is essential for the homeostasis of plenty of minerals, particularly controlling the calcium ratio, immunological roles, and antioxidant and anti-fibrotic properties. Furthermore, it lessens death and necrosis of various cells, producing nephron-protective roles (24). There are renal tissue shortages and functional tissue loss following radical nephrectomy in patients, leading to low levels of renal vitamin D; therefore, the almost normal level of vitamin D is necessary to sustain its important roles beyond bone metabolism as a result of the presence of vitamin D receptors in most body tissues thus enabling it to perform many duties such as erythroid precursor propagation, blood vessels formation, manufacture and encouragement of cellular maturation, and controlling of the immune response (27).

The biochemical tests indicate that concentrations of both EPO and vitamin D decreased sharply following unilateral removal tile day 15 post excision, agreeing with other researchers' findings who found that the residual kidney was unable to perform the biological role of the other kidney during the first two weeks post-operative (13,47). Hoontrakul *et al.* (53) noticed the same trend of decreased changes in the concentration of the EPO and vitamin D3 in the rabbit group one month after nephrectomy. While Ali and Al-Kattan (54) noticed that there was a deficiency of 1,25-dihydroxycholecalciferol in almost 58 % of patients following unilateral kidney removal. However, their concentrations started to rise high gradually during the first month in an obvious indication of the improvement in the functional compensatory mechanism of the remaining kidney that was also documented by other researchers Rothem *et al.* (29), Hoontrakul *et al.* (53), Ali and Al-Kattan (54), Lee *et al.* (55), Shimada *et al.* (56).

Because the kidney produces around 90% of systemic EPO (20), besides its enormous physiological effects, it was so critical to estimate its values before and after nephrectomy to be aware of the impact of that radicle removal on its rate as decreased renal erythropoietin production will cause anemia (57). The results indicate the presence of a sharp decline in its rate immediately after surgery; this coincides with Geis and Kurtz (58) and that erythropoietin has a significant role in the regulation of oxygen-carrying capacity that could lead to anemia which would be more happening in patients experiencing radical nephrectomy comparable to partial nephrectomy (21) due to reduction in filtration ratio, and these elevated tissue oxygen grades lead to decline in renal ability to produce erythropoietin and anemia (57) that can be associated with bad prognosis, lessened life' value, enlarged frequencies of cardiopulmonary sicknesses, and even higher mortality rate (27).

Conclusions

The laparoscopic, ultrasonographic, and biochemical outcomes of this in vivo experiment clearly displayed that unilateral radical nephrectomy is largely associated with the presence of dimensional and endocrinal physiological compensatory mechanisms exhibited by the remaining kidney in cats.

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Conflict of interest

The writers of this article announce that there are no conflict issues related to its publications.

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نتائج الأمواج فوق الصوتية وبعض القيم الكيموحياتية بعد إزالة الكلية الكلي في القطط

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الخلاصة

في الطب البيطري، أصبح الاستئصال الجراحي الكامل للكلية باستخدام المنظار في الكلاب والقطط هو الاتجاه العلمي الأكثر قبولًا مقارنة بالجراحة المفتوحة التقليدية نتيجة لفوائدها العظيمة. هذا الاستئصال من شأنه أن يؤثر على بعض مستويات الهرمونات وقياسات الموجات فوق الصوتية للكلية المتبقية أما كعواقب لاحقة أو حتى كآلية تعويضية. وللتأكد من هذه النتائج، تم التخطيط لهذا العمل من خلال استخدام ستة عشر قطة بالغة من السلالة المحلية كنموذج تجريبي. تم اخذ عينات أساسية من الدم وفحوصات الموجات فوق الصوتية قبل الجراحة لتكون أساسا لمقارنة التغييرات الحاصلة في المعايير المدروسة، ومن ثم تم استئصال كامل للكلية اليسرى بالمنظار للحيوانات. تم إجراء التقييم بعد الاستئصال باستخدام نتائج الموجات فوق الصوتية والكيميائية الحيوية لتركيزات إريثروبويتين وفيتامين د في الأيام ١٥ و٣٠ و٦٠ التي تلت الاستئصال. أثبتت الفحوصات بالموجات فوق الصوتية كفاءة استئصال الكلية الكلي باستخدام المنظار، كما أظهرت وجود تضخم واضح في حجم الكلى المتبقية بالإضافة إلى وجود زيادة تعويضية تدريجية كبيرة في أبعادها المقاسة والتي بدأت منذ الأسبوع الثاني بعد الاستئصال حتى نهاية الدراسة في جميع القطط التجريبية مقارنة بأبعادها قبل الجراحة. إلى جانب ذلك، كشفت نتائج الكيميائية الحيوية لإريثروبويتين وفيتامين د في الأيام المحددة عن وجود زيادة تعويضية تدريجية كبيرة في تركيزهما منذ الأسبوع الرابع بعد الاستئصال حتى نهاية اليوم ٦٠. الخلاصة، إن استئصال الكلية الكلي يرتبط ارتباطًا وثيقًا بوجود آلية تعويضية كيميائية حيوية وفوق صوتية متكيفة تظهرها الكلية المتبقية من خلال تضخم حجمها، وارتفاع معدلات إريثروبويتين وفيتامين د المفرزين.