



Review Article



Small Animal Ovariohysterectomy and Avoidance of Associated Complications in Pet Practices Across Pakistan: A Current Perspective

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ABSTRACT

Ovariohysterectomy (OVH) is a routine surgical procedure in small animal practices for sterilization and management of several uterine diseases, namely pyometra, cystic endometrial hyperplasia, uterine tumors, rupture, and torsion. Ovariohysterectomy (OVH) offers numerous clinical advantages, but post-operative complications could pose financial challenges for veterinarians due to the inherent risk of malpractice suits and clients owing to the extended recovery period for their pets. The authors reviewed about two dozen peer-reviewed English language articles from PubMed, Scopus, Web of Science, and Google Scholar databases to identify risks and avoidance strategies following OVH. These may include the ones arising from celiotomy (infection, incisional hernias, wound dehiscence, inadvertent injury to organs and adhesions) or affections, such as intraoperative hemorrhage, stump pyometra, ovarian remnant syndrome, ureteral ligation, urinary incontinence, granulomas, fistulous tracts, post-surgery weight gain, and eunuchoid syndrome. This review emphasizes prevention and management methods for each of these complications. Effective surgical techniques play a vital role in preventing hemorrhage, while meticulous resection, ligation, and omentalization of uterine stump reduce the risk of stump pyometra. Complete removal of ovarian tissue and systematic exploration prevent ovarian remnant syndrome. The use of advanced imaging methods, such as ultrasound, fluoroscopy, or CT scans, can greatly aid in identifying and preserving ureters during surgical procedures, thus minimizing the risk of ureteral complications. Strategies to address urinary incontinence, granulomas, and post-surgery weight gain might encompass the use of hormonal therapy involving estradiol analogs or the application of precise surgical techniques involving ureteral reimplantation. Innovative strategies such as auto-transplantation of ovaries are suggested for managing eunuchoid syndrome, while inadvertent prostatectomy and bowel obstruction may simply be avoided by better tissue handling and dissection. In summary, optimizing surgical protocols, incorporating CT scans, using appropriate drug therapies, and continuous education within the veterinary community are crucial for reducing complications associated with OVH.

1. Introduction

Ovariohysterectomy (OVH) refers to the complete removal of ovaries and uterus¹. This procedure is performed to sterilize animals. Sterilization of small animals or pets typically refers to the surgical procedure

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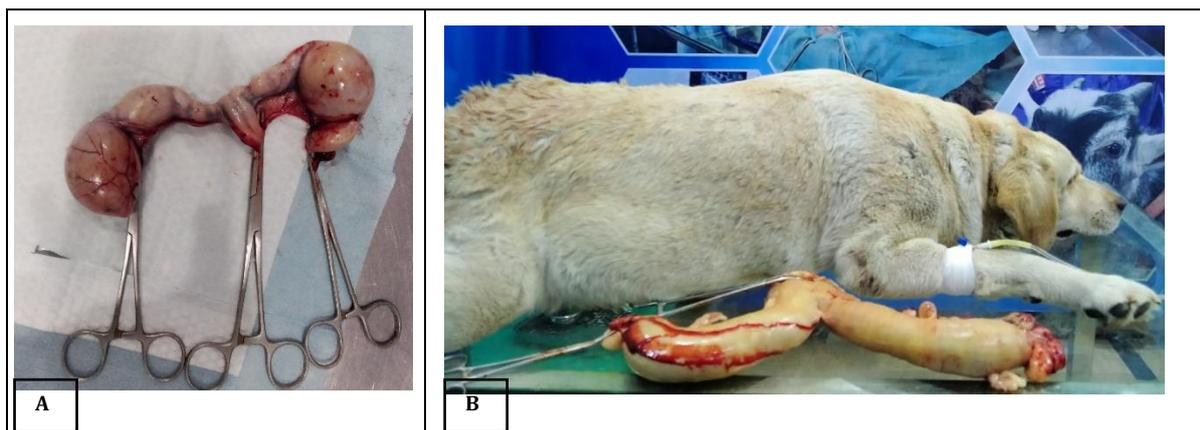


Figure 1. Abnormal reproductive tracts in small animals photographed at the Veterinary Teaching Hospital, Cholistan University of Veterinary and Animal Sciences, Bahawalpur, Pakistan. Ovariohysterectomy performed in a Persian cat suffering from a severe case of pyometritis (A); Ovariohysterectomy performed in a 2-year-old Labrador female dog suffering from a severe case of pyometritis (B).

known as spaying (for females) or neutering (for males). These procedures are performed by veterinarians and are aimed at preventing the animals from reproducing. Sterilization is an essential aspect of responsible pet ownership and is often recommended to help manage the pet population and reduce the number of homeless animals in shelters. It can also have positive effects on the pet's behavior and long-term health. It is important to consult with a veterinarian to determine the most appropriate timing for sterilization based on the individual animal's age, breed, and health status². Moreover, it is indicated as a treatment of choice for most uterine diseases, namely uterine neoplasia, uterine torsion, pyometra, uterine rupture, and localized or diffused cystic endometrial hyperplasia³ (Figure 1). Ovariohysterectomy (OVH) is a frequently performed surgical procedure that offers numerous benefits. However, there is an ongoing concern regarding potential complications, including intraoperative hemorrhaging, stump pyometra, ovarian remnant syndrome, ureteral ligation, urinary incontinence, granulomas, fistulous tracts, weight gain, and eunuchoid syndrome⁴. Ovariohysterectomy may also be employed as an adjunctive therapy for mammary neoplasia, neutralizing the role of endogenous estrogen in the spontaneous growth of mammary tumors⁵. Performing ovariohysterectomy (spaying) in epileptic and diabetic female dogs has the potential to mitigate the risk of drug interactions with female hormones and offers several advantages⁶. Studies have indicated that spaying eliminates the hormonal fluctuations observed during the estrus (heat) cycle in intact females, which could occasionally trigger seizures in epileptic dogs⁷. Furthermore, in cases where female dogs already have epilepsy, spaying ensures they do not encounter hormone-related changes that might interfere with antiepileptic medications, leading to enhanced management of epilepsy⁸. Prior research has also documented hormonal variations during the estrus cycle that can impact blood sugar levels in diabetic dogs⁹. Spaying effectively prevents these hormonal fluctuations, contributing to better control of blood sugar¹⁰. Similar to epileptic dogs, spaying ensures that diabetic dogs

maintain more consistent hormone levels, facilitating stable blood glucose levels during medication and dietary management¹¹. It is important to emphasize that while spaying can assist in the management of these conditions, it does not guarantee a cure. A comprehensive approach to managing epilepsy and diabetes in dogs should encompass medication, dietary considerations, and regular veterinary care. Researchers have proposed several different techniques to undertake surgical sterilization in female dogs and cats. However, ovariohysterectomy through a ventral midline incision is most often performed by small animal practitioners in Pakistan¹. Many researchers have brought attention to an intriguing paradox in which the majority of veterinary surgeons, despite having the requisite expertise to perform ovariohysterectomy effectively, still see approximately 20% of patients experiencing postoperative complications. This phenomenon has been rationalized in prior manuscripts by emphasizing the sheer volume of such procedures being conducted¹².

This review aims to provide a comprehensive overview of strategies and methodologies to effectively mitigate complications after OVH, ensuring optimal patient outcomes and minimizing associated risks. A thorough exploration of existing literature was undertaken to curate a comprehensive understanding of complications linked to OVH. The review addresses an array of complications, ranging from intraoperative hemorrhage and wound healing challenges to more intricate concerns such as ovarian remnant syndrome, stump pyometra, uterine stump abscess formation, urinary incontinence, and other complications relevant to this surgical intervention.

2. Complications and sequelae

2.1. Hemorrhage

The probability of intra-operative hemorrhaging is considerable in larger-sized dogs¹³. However, the incidence of postoperative secondary hemorrhaging is quite improbable when surgeons are well-versed in surgical protocols¹⁴. Unintended tearing of the ovarian pedicle

while dissecting the suspensory ligament or damage to large uterine vessels due to excessive traction may be attributed to most instances of intra-operative hemorrhaging while spaying. Therefore, all hemostats must be carefully secured in their place before excising any ovarian or uterine structures¹². Surgical incisions should be enlarged if surgeons experience difficulty in gaining appropriate access to the ovarian arteriovenous (AV) complex. In some situations, improper placement of ligatures or failure of suture material could also cause serious intra-operative and post-operative hemorrhaging¹⁵. Dogs have extremely well-developed ovarian AV complexes, so ovarian pedicles, and uterine stumps should be double ligated, once using circumferential ligature followed by placing a trans-fixational one to avoid suture slippage⁶. Intra-operative hemorrhage could also be observed when practitioners cannot correctly locate linea alba and instead incise through the rectus muscle, thereby entering the abdominal cavity through a paramedian approach¹⁶. Patients with significant mammary development have quite pronounced vasculature in the subcutaneous tissue, which may be transected during surgery. These vessels could also continue to bleed during and after surgery¹⁷. Optimal surgical technique plays a pivotal role in complication avoidance. Achieving thorough surgical field exposure, gentle tissue manipulation, and meticulous ligation techniques are fundamental to preventing complications such as hemorrhage, tissue trauma, and adhesion formation¹⁸. Furthermore, the choice of suture material, favoring monofilament absorbable sutures, can reduce the risk of tissue reactions, promoting effective wound healing. A previous study has suggested that postoperative death due to hemorrhage occurred in only 1 of 1016 dogs and 1 of 1459 cats undergoing elective sterilization or onychectomy, popularly known as declawing¹². However, considering the low mortality rates reported in prior studies, it seems that intraoperative hemorrhage during ovariohysterectomy (OVH) seldom leads to life-threatening outcomes¹⁴.

2.1. Pyometra of uterine stump

The small portion of the uterine body or cervix that is left inside the bitches could become infected due to elevated blood progesterone levels¹⁴. This situation is often observed in cases where either a small portion of the ovary is inadvertently left inside during ovariohysterectomy or progesterone is consumed by the patient from exogenous sources. Effectively preventing stump pyometra involves meticulous resection of the uterine stump during OVH¹². Proper ligation techniques, adherence to guidelines for surgical closure, and omentalization of the stump help reduce the risk of bacterial contamination and subsequent infection¹². Maintaining a high level of vigilance throughout the surgical procedure, along with a meticulous approach to achieving hemostasis (the control of bleeding) and a thorough focus on the careful handling of tissues, collectively play a vital role in preventing this potentially severe complication from occurring.

2.2. Recurrent estrus (ovarian remnant syndrome)

Residual ovarian tissue left inside the patient following an incomplete ovariohysterectomy could lead to recurrent estrus¹⁹. These ovarian remnants continue to produce hormones and patients continue to present behavioral signs associated with heat even after ovariohysterectomy. These hormonal effects may be observed sometime after surgery, only after vascularity resumes to the remnant tissue or it grows to an adequate size¹⁴. The condition could only be permanently corrected by surgically exploring the abdominal cavity diligently and excising the remnant after careful ligation^{19,20}. Research has shown that residual ovarian tissue is more commonly found on the right side¹⁹⁻²¹. The prevention of ovarian remnant syndrome hinges on the meticulous removal of all ovarian tissue during OVH. Researchers have concluded that surgeons must prioritize complete visualization and systematic exploration of the surgical site, employing techniques such as abdominal ultrasound and exploratory laparotomy to identify and eliminate any retained ovarian tissue¹². This approach ensures the patient's well-being and minimizes the risk of recurrent estrus behavior.

2.3. Ligation of ureter

Unintentional ligation of a ureter is a possible complication of ovariohysterectomy in bitches and queens⁶. In a poorly exposed ovarian pedicle, hemostats could inadvertently clamp on the ureter, or an improper ligature around the uterine body could crush it⁶. Such malpractice is followed by a slew of serious post-operative complications being experienced by the patient, including pyelonephritis and hydronephrosis. As ureters are likely to be included in a uterine body ligature if the bladder is full, evacuation of the urinary bladder preoperatively is strongly recommended⁶. Mitigating ureteral injury during OVH entails comprehensive identification and preservation of the ureters. Advanced imaging techniques, such as intraoperative ultrasound, facilitate real-time visualization of ureteral anatomy, minimizing the potential for inadvertent damage⁶. Ensuring thorough training and utilization of specialized equipment are integral to maintaining surgical precision and avoiding ureteral complications.

2.4. Incontinence of urine

Low estrogen levels, consequent to ovariohysterectomy, could be responsible for causing urinary incontinence. Moreover, granulomas or generalized adhesions of uterine remnants may also impede the function of the urinary bladder sphincter. Urinary incontinence attributed to low estrogen levels could be medicinally mitigated by oral administration of phenylpropanolamine (1.5-2.0 mg/kg PO) twice or thrice in a day⁶. Estrogen analogs, namely diethylstilbestrol administered at 0.1-1.0 mg/day have also been known to yield favorable results¹⁴. A comprehensive

understanding of the underlying mechanisms of acquired urinary incontinence is essential for its management. Practitioners should consider tailored surgical techniques that preserve anatomical structures responsible for continence, thus minimizing the risk of urethral sphincter mechanism incompetence (USMI). The integration of drug therapies, such as sympathomimetic agents (e.g., phenylpropanolamine) and estrogen-related drugs (e.g., diethylstilbesterol), offers a multifaceted approach to maintaining continence in at-risk patients²².

2.5. Granulomas and fistulous tracts

Certain animals experience a serious tissue reaction to the absorbable material that has been implanted as sutures. This results in the formation of sub-lumbar fistulous tracts in spayed bitches. This is the reason absorbable monofilament suture materials with lower capillarity and bacterial adherence are preferred for OVH. These fistulous tracts are often observed months after the surgical intervention and are most prevalent near the flank region of animals²³. Granulomas caused as a result of tissue reaction at the ovarian pedicle could impose greater systemic implications by causing pyelonephritis and hydronephrosis, while uterine stump granulomas may lead to pollakiuria, cystitis, and obstructed bowels. Surgical removal of the offending structure is the only reasonable treatment for this malady²⁴.

2.6. Body weight gain

Weight gain after ovariectomy has been previously reported^{14,25}. This phenomenon is especially notable in cats. However, the physiological mechanism responsible for such outcome is poorly understood. Some researchers have hypothesized that estrogen acts as a satiety factor, and its absence from the system causes the animals to overeat¹⁴. Others suggested that feline and canine fat deposits are especially prone to estradiol, elevating fat deposition by inhibiting lipoprotein lipase enzyme²⁶.

2.7. Eunuchoid syndrome

The eunuchoid syndrome can sometimes be seen in working dogs following ovariectomy. By sexually neutering these female dogs, hormones essential for aggression and stamina are thereby removed from animal physiology. This is a serious issue in the case of working or athletic dogs. The incidence of eunuchoid syndrome is quite rare in female cats following ovariectomy²⁷. The removal of the ovaries and uterus can result in a decline in sex hormone production. However, it rarely leads to the development of eunuchoid syndrome, as is sometimes seen in male cats²⁸. Most spayed female cats do not exhibit such significant hormonal changes, and the procedure is generally considered safe and routine for them²⁹. Some researchers have proposed an innovative plan that involves auto-transplantation of an ovary to gastric serosa to mitigate this

situation¹⁴. This allows the organ to continue producing progesterone and estradiol at very minute levels that are insufficient for initiating estrus, while simultaneously averting eunuchoid syndrome by maintaining adequate serum concentrations.

2.8. Complications associated with celiotomy

Surgeons may inadvertently puncture the urinary bladder or spleen while incising through the musculature of the abdomen or even fail to remove all gauze sponges from the abdominal cavity before closure. This could result in either immediate exsanguination or serious long-term implications associated with peritonitis and incisional dehiscence¹⁷. Improper tissue handling during suturing could also lead to serious postoperative discomfort for the animal, causing them to self-mutilate and damage the suture line. Reports have also documented postoperative herniation of abdominal contents in cases where the muscular wall was inadequately sutured or closed¹².

2.10. Prevention of bowel obstruction

Efficient prevention of bowel obstruction following OVH requires a combination of meticulous tissue handling, optimal closure techniques, and thoughtful consideration of suture materials¹². Utilizing monofilament absorbable sutures, performing gentle dissection, and minimizing tissue trauma can mitigate the formation of adhesions and reduce the risk of bowel obstruction post-surgery.

3. Conclusion

In the realm of small animal veterinary practice in Pakistan, ovariectomy (OVH) stands as a pivotal procedure for both reproductive management and therapeutic intervention. While its benefits are well-established, the concern for potential complications looms large. This review has delved comprehensively into the spectrum of complications associated with OVH, presenting a nuanced understanding of each challenge and proposing strategies for their avoidance. Undoubtedly, the pursuit of surgical excellence forms the bedrock for complication mitigation. The surgeon's expertise, coupled with refined techniques, meticulous tissue handling, and the integration of advanced imaging modalities, can substantially diminish the likelihood of adverse outcomes. These protocols are particularly pertinent for intraoperative hemorrhage, stump pyometra, and inadvertent prostatectomy, where precision and comprehensive anatomical awareness are paramount. Beyond the operating room, pharmacological interventions present a multifaceted approach for complications such as urinary incontinence and eunuchoid syndrome. With the judicious use of sympathomimetic agents and estrogen-related drugs, practitioners can offer patients an enhanced quality of life post-OVH. Furthermore, innovative strategies, like auto-transplantation of ovaries to maintain hormonal equilibrium, provide a glimpse into the future of surgical intervention. Continuous research, dialogue, and

collaboration within the veterinary community are vital to refine and advance the understanding of OVH and its related complications. Emphasis on education, skill development, and sharing experiences can collectively elevate the standards of surgical practice across Pakistan. It is the collective responsibility of veterinary professionals to ensure that OVH, a cornerstone of small animal medicine, is executed with the utmost precision, care, and dedication. In the evolving landscape of veterinary medicine, the pursuit of excellence remains unwavering, driven by an enduring commitment to the well-being of companion animals. Hence, it is recommended that the Veterinary Regulatory Council in Pakistan take steps to standardize surgical protocols, facilitate ongoing education for veterinarians, promote data collection, and enhance public awareness. Additionally, researchers are encouraged to investigate the long-term health implications, advanced approaches to managing complications, behavioral consequences, regional disparities, alternative sterilization methods, and conduct cost-benefit analyses to reduce the risks associated with ovariectomy in companion animals.

Declarations

Competing interests

Authors declare that there was no competing interest.

Authors' contributions

The initial draft of the manuscript was conceived by Ameer Hamza Rabbani, Omer Naseer, and Kashif Hussain. Data was collected by Muhammad Shahid, and Qudratullah. Revision and final proofreading of the manuscript were accomplished by Abdullah Saghir Ahmad, Fazal Wadood, and Muhammad Luqman Sohail. All authors checked and confirmed the text of the manuscript.

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Availability of data and materials

The manuscript contains all datasets generated and/or analyzed in the current study.

Ethical Considerations

All applicable international, national, and/or institutional guidelines for the care and use of animals were followed.

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References

1. Rabbani AH, Khan YR, Naseer O, Ullah Q, Safwan HM, Waheed A, et al.

- Biocompatibility and postoperative complications of different subcutaneous suturing methods in cats undergoing ovariohysterectomy by midline incision. *Thai J Vet Med.* 2021; 51(3): 577-585. Available at: <https://he01.tci-thaijo.org/index.php/tjvm/article/view/251082>
- Landry J, and Maza P. Effectiveness of the anaesthetic combination of tiletamine, zolazepam, ketamine and xylazine for the sterilisation of street dogs in field clinics. *Vet Rec Case Reports.* 2020; 8(2):e000953, DOI: [10.1136/vetreccr-2019-000953](https://doi.org/10.1136/vetreccr-2019-000953)
- Ajadi TA, Makinde FA, Adebayo OO, and Adeleye AI. Incidence, indication and prognosis of ovariohysterectomy in dogs in Abeokuta, Nigeria. *Sokoto J Vet Sci.* 2018; 16(2):47-53. DOI: [10.4314/sokjvs.v16i2.7](https://doi.org/10.4314/sokjvs.v16i2.7)
- Buote NJ, and Fransson BA. Laparoscopic ovariectomy, ovariohysterectomy, and hysterectomy. *Small animal laparoscopy and thoracoscopy.* Wiley-Blackwell; 2022. p. 254-266.
- Cassali GD, Jark PC, Gamba C, Damasceno KA, Lima AE, Nardi AB de, et al. Consensus regarding the diagnosis, prognosis and treatment of canine and feline mammary tumors 2019. *Brazilian J Vet Pathol.* 2020; 13(3): 555-574. DOI: [10.24070/bjvp.1983-0246.v13i3p555-574](https://doi.org/10.24070/bjvp.1983-0246.v13i3p555-574)
- Plater BL, and Lipscomb VJ. Treatment and outcomes of ureter injuries due to ovariohysterectomy complications in cats and dogs. *J Small Anim Pract.* 2020; 61(3): 170-176. DOI: [10.1111/jsap.13100](https://doi.org/10.1111/jsap.13100)
- Berendt M, Gredal H, Ersbøll AK, and Alving J. Premature death, risk factors, and life patterns in dogs with epilepsy. *J Vet Intern Med.* 2007; 21(4): 754-759. DOI: [10.1111/j.1939-1676.2007.tb03017.x](https://doi.org/10.1111/j.1939-1676.2007.tb03017.x)
- Nelissen P, and White D. Ovariectomy vs ovariohysterectomy: An update on current trends. *UK Vet Companion Anim.* 2010; 15(3): 19-27. DOI: [10.1111/j.2044-3862.2010.tb00459.x](https://doi.org/10.1111/j.2044-3862.2010.tb00459.x)
- Kreilmeier-Berger A, Bilek A, and Künzel FTGDA. Remission of diabetes mellitus after ovariohysterectomy in a guinea pig with ovarian cysts. *Tierärztliche Praxis.* 2019; 47(1): 55-59. DOI: [10.1055/a-0828-6657](https://doi.org/10.1055/a-0828-6657)
- Fall T, Hedhammar Å, Wallberg A, Fall N, Ahlgren KM, Hamlin HH, et al. Diabetes mellitus in elkhounds is associated with diestrus and pregnancy. *J Vet Intern Med.* 2010; 24(6): 1322-1328. DOI: [10.1111/j.1939-1676.2010.0630.x](https://doi.org/10.1111/j.1939-1676.2010.0630.x)
- Kim I, Choi J, Hwang D, and Kang H. Remission of progesterone-induced diabetes mellitus after ovariohysterectomy in an intact female dog. *J Vet Clin.* 2019; 36(1): 74-77. DOI: [10.17555/jvc.2019.02.36.174](https://doi.org/10.17555/jvc.2019.02.36.174)
- Adin CA. Complications of ovariohysterectomy and orchietomy in companion animals. *Vet Clin Small Anim Pract.* 2011; 41(5): 1023-1039. DOI: [10.1016/j.cvsm.2011.05.004](https://doi.org/10.1016/j.cvsm.2011.05.004)
- Doodnaught GM, O'Toole E, and Pang DSJ. Management of a severe peripartum hemorrhage following cesarean section in a dog. *Can Vet J.* 2020; 61(6): 589-594. PMID: <https://pubmed.ncbi.nlm.nih.gov/32675810>
- Melo CJB, Martínez JMA, and Rojas ML. Complications of surgical sterilization by ovariohysterectomy in female dogs: A systematic review. *Rev Med Vet.* 2018; 1(37): 83-93. DOI: [10.19052/mv.vol1.iss37.10](https://doi.org/10.19052/mv.vol1.iss37.10)
- Belluzzi E, Santos MA, Jifcovici A, Redolfi G, Di Virgilio F, Deneuche A, et al. Comparison of the incidence of intra-operative haemorrhage from ovarian vessels during ovariectomy and ovariohysterectomy of dogs and cats performed by inexperienced surgeons using surgeon's and constrictor knots. *N Z Vet J.* 2022; 70(2): 88-94. DOI: [10.1080/00480169.2021.1985648](https://doi.org/10.1080/00480169.2021.1985648)
- Freeman LJ, Petit GD, Robinette JD, Lincoln JD, and Person MW. Tissue reaction to suture material in the feline linea alba a retrospective, prospective, and histologic study. *Vet Surg.* 1987; 16(6): 440-445. DOI: [10.1111/j.1532-950x.1987.tb00984.x](https://doi.org/10.1111/j.1532-950x.1987.tb00984.x)
- Khalifa MI, Kassem MM, El-Kammar MH, and Abu-Ahmed HH. Comparison of ovariohysterectomy, ovarian electrocautery, and ovarian blood supply ligation for elective sterilization of bitches. *Alexandria J Vet Sci.* 2020; 67(1): 99-105. DOI: [10.5455/ajvs.135585](https://doi.org/10.5455/ajvs.135585)
- Benito J, Evangelista MC, Doodnaught GM, Watanabe R, Beauchamp G, Monteiro BP, et al. Analgesic efficacy of bupivacaine or bupivacaine-dexmedetomidine after intraperitoneal administration in cats: A randomized, blinded, clinical trial. *Front Vet Sci.* 2019; 6(1): 307. DOI: [10.3389/fvets.2019.00307](https://doi.org/10.3389/fvets.2019.00307)
- Flock U, Fischer S, Weeger J, Reese S, and Walter B. Anti-Müllerian hormone as a diagnostic tool to identify queens with ovarian remnant syndrome. *J Feline Med Surg.* 2022; 24(8): e168-e174. DOI: [10.1177/1098612X221099195](https://doi.org/10.1177/1098612X221099195)

20. Weedon GR, and Kustritz MVR. Ovarian remnant syndrome. In: White S, editor. High-quality, high-volume spay and neuter and other shelter surgeries. John Wiley & Sons, Inc; 2020. p. 363-369.
21. Percival A, Singh A, Gartley C, Balsa I, Case JB, Mayhew PD, et al. Single-port laparoscopic treatment and outcome of dogs with ovarian remnant syndrome: 13 cases (2010–2018). *J Am Anim Hosp Assoc.* 2020; 56(2): 114-119. DOI: [10.5326/JAAHA-MS-6923](https://doi.org/10.5326/JAAHA-MS-6923)
22. Beceriklisoy HB. Effectiveness of different pharmacological approaches on post-ovariohysterectomy urinary incontinence in the bitch. *Ankara Univ Vet Fak Derg.* 2005; 52: 157-160.
23. Shea EK, Berent AC, and Weisse CW. Vesicovaginal fistula in a dog with urinary incontinence. *J Am Vet Med Assoc.* 2019; 255(4): 466-470. DOI: [10.2460/javma.255.4.466](https://doi.org/10.2460/javma.255.4.466)
24. Dempsey L. Ovariohysterectomy: Avoid the pitfalls. *BSAVA Congress Proceedings 2016.* BSAVA Library; 2016. p. 98-99.
25. Wahyuni RM, Gunanti G, and Noviana D. The effect of age on wound healing and physical development of local cats (*Felis catus*) post-ovariohysterectomy surgery. *J Kedokt Hewan-Indonesian J Vet Sci.* 2023; 17(2): 48-52. DOI: [10.21157/j.ked.hewan.v17i2.28242](https://doi.org/10.21157/j.ked.hewan.v17i2.28242)
26. Torabi Asl M, Yasini SP, and Shirazi Beheshtiha SH. Evaluation of antioxidant enzymes and lipid peroxidation before and after ovariohysterectomy in queen. *Iran Vet J.* 2022; 18(1): 71-76. DOI: [10.22055/ivj.2021.316307.2415](https://doi.org/10.22055/ivj.2021.316307.2415)
27. Howe LM. Surgical methods of contraception and sterilization. *Theriogenology.* 2006; 66(3): 500-509. DOI: [10.1016/j.theriogenology.2006.04.005](https://doi.org/10.1016/j.theriogenology.2006.04.005)
28. Mogheiseh A, Nikahval B, Ahmadi N, Yazdanpanah R, Sadat Z, and Nazifi S. Bilateral ovarian pedicle ligation as an alternative to ovariectomy and ovarian response to eCG treatment. *Comp Clin Path.* 2017; 26(1): 197-202. DOI: [10.1007/s00580-016-2369-z](https://doi.org/10.1007/s00580-016-2369-z)
29. De Cramer K, and May K. A review of sterilisation. *Vet360.* 2015; 2(1): 11-19. Available at: https://www.cpd solutions.co.za/Publications/article_uploads/Vet360_CPD_2015.pdf