Artykuł przeglądowy *Review*

Bioresorbable stents in veterinary medicine: applications in respiratory, digestive, cardiovascular, and urinary systems in dogs, cats, and horses

JOANNA SKONIECZNA-KURPIEL

Department of Food Hygiene and Consumer Health Protection, Faculty of Veterinary Medicine, Wrocław University of Environmental and Life Sciences, Norwida 31, 50-375 Wrocław, Poland

Received 06.02.2026 *Accepted 23.04.2026*

Skonieczna-Kurpiel J.

Bioresorbable stents in veterinary medicine: applications in respiratory, digestive, cardiovascular, and urinary systems in dogs, cats, and horses

Summary

Bioresorbable stents are an emerging technology in veterinary medicine, with research predominantly focused on dogs and only limited data available for cats and horses. Their application in the respiratory system remains largely experimental, although early canine studies have demonstrated feasibility and short-term biocompatibility despite reported complications. In the digestive system, particularly in the treatment of esophageal strictures, bioresorbable stents show promising clinical potential in dogs and cats, whereas evidence in horses is still lacking. Cardiovascular applications are also at an early experimental stage, with encouraging short-term results but limited long-term data. Currently, the urinary system represents the most advanced area of application, with studies in dogs and case reports in horses demonstrating favorable outcomes and effective degradation without the need for removal. Overall, further research, including large-scale and long-term studies, is required to optimize materials, confirm safety and efficacy, and expand clinical use across species.

Keywords: bioresorbable stents, dogs, cats, horses

In recent years, there has been a dynamic advancement in modern medical technologies, with applications extending beyond human medicine into veterinary practice. One particularly promising approach is the use of bioresorbable stents as an alternative to conventional metallic implants. These devices offer several significant advantages, which contribute to their increasing consideration in clinical settings. They provide mechanical support only during the healing phase, after which they undergo degradation, thereby restoring the organ's natural function. Their gradual resorption within the body eliminates the need for an additional surgical intervention, which is of considerable importance for both animal welfare and the overall course of treatment. Furthermore, they reduce the risk of chronic inflammation, infection, and excessive tissue proliferation associated with permanent implants. Bioresorbable materials are generally well tolerated by the organism. The absence of a permanent foreign body also diminishes the long-term risk of stent migration or structural failure (8, 18, 19, 43, 48, 51). In veterinary medicine, stent implantation is typically performed on an outpatient basis and, although less prevalent than in human medicine, can be life-saving.

Early prototypes of bioresorbable stents were excessively rigid, insufficiently elastic, and prone to migration or collapse, resulting in failure to maintain luminal position. Degradation fragments frequently caused mucosal injury, and sudden stent collapse occasionally led to acute obstruction (27, 29). Contemporary design criteria for bioresorbable stents include controlled degradation or absorption within the body, smooth delivery during compression, and sufficient radial force to effectively dilate stenoses after implantation (16, 71). Appropriate biomaterial selection is critical for optimal stent performance. Frequently used polymers include poly(lactic acid) (PLA), poly(glycolic acid) (PGA), polycaprolactone (PCL), poly(ethylene adipate) (PEA), and poly(p-dioxanone) (PDO) (31, 47).

Bioresorbable polymers such as PLA, PGA, PCL, PEA and PDO belong to the group of aliphatic polyesters that degrade via hydrolysis of ester bonds, leading to the formation of metabolizable α-hydroxy acids (58). Their mechanical properties and degradation kinetics depend on molecular structure, crystallinity, and copolymer composition (1). PLA is characterized by good biocompatibility and widespread clinical use; however, its brittleness and limited control over degradation remain significant drawbacks (61). In contrast, PGA exhibits higher mechanical strength but undergoes faster degradation, which may result in premature loss of implant stability (57). PCL, on the other hand, is distinguished by a very slow degradation rate and high elasticity, making it suitable for long-term applications (61).

Tab. 1. Comparison of selected bioresorbable biomaterials used in human and veterinary medicine

Material	Type	Mechanical properties	Degradation rate	Biocompatibility	Advantages
PLA	Aliphatic polyester	Moderate strength, relatively high stiffness	Slow (months–years)	Very good	Good mechanical stability, widely used clinically
PGA	Aliphatic polyester	High strength and stiffness	Fast (weeks–months)	Good	High initial strength, good tissue integration
PCL	Aliphatic polyester	Low strength, very high elasticity	Very slow (years)	Very good	High formability, long-term stability
PEA	Aliphatic polyester	Low to moderate strength	Relatively fast	Good	Flexibility, biodegradability
PDO	Aliphatic polyester	Moderate strength, good elasticity	Moderate	Very good	Balanced mechanical and degradation properties

PEA is far less extensively studied, and its relatively low mechanical strength and limited long-term stability have restricted its broader clinical application (63). PDO is widely used as a bioresorbable biomaterial due to its favorable combination of flexibility, biocompatibility, and a controlled degradation profile. Moreover, it exhibits a relatively prolonged resorption time (approximately 4-8 months *in vivo*), allowing it to provide temporary mechanical support during tissue healing while avoiding the need for secondary implant removal. This makes it particularly attractive for both clinical and veterinary applications (31). Key information on the above biomaterials is summarized in Table 1, with data derived from references (1, 31, 57, 58, 61, 63).

Modern stents may additionally be coated with bioactive substances designed to accelerate tissue healing, reduce inflammatory responses, and minimize adverse effects associated with implantation (25, 56). These coatings enable the controlled, local release of therapeutic agents directly at the target site, thereby enhancing efficacy while limiting systemic exposure. Commonly used compounds include immunomodulatory and antiproliferative agents such as biolimus, sirolimus, zotarolimus, paclitaxel, and trioxide arsenic, which act by inhibiting excessive neointimal hyperplasia and reducing the risk of restenosis. In parallel, antimicrobial agents such as ciprofloxacin, rifampicin, vancomycin, and gentamicin are incorporated to prevent bacterial colonization and biofilm formation on the stent surface, thereby reducing the risk of implant-associated infections (9, 20, 35, 45, 46, 66). The combination of these pharmacological strategies contributes to improved clinical outcomes by promoting proper tissue integration and reducing both short- and long-term complications.

This review synthesizes current knowledge on bioresorbable stents in veterinary medicine, focusing on their applications in the respiratory, digestive, cardiovascular, and urinary systems of dogs, cats, and horses.

Implantation of bioresorbable stents in the respiratory tract of dogs, cats, and horses

in veterinary medicine, stenting is most commonly used to support the trachea and the proximal parts of the bronchial tree. It is indicated in drug-resistant airway collapse, including tracheomalacia, tracheobronchomalacia, and bronchomalacia. These conditions are most frequently observed in small breeds such as Yorkshire Terriers, Chihuahuas, Pomeranians, Pugs, and Miniature Poodles, although large-breed dogs may also be affected (23, 33). For these reasons, the development of bioresorbable stents for dogs is justified.

A group of scientists evaluated the feasibility of delivering a novel poly-L-lactic acid (PLLA) tubular airway stent using a balloon catheter under bronchoscopic guidance in a canine model. Six Beagle dogs (approximately 10 kg each) were included in the study. All stents were successfully delivered and deployed into the tracheal lumen without technical complications. One month after implantation, the PLLA stents were covered with tracheal mucosa; however, marked granulation tissue at the distal end was observed in one dog. Autopsy revealed an incomplete laceration of the membranous portion of the trachea. The authors reported promising results, but emphasized that further studies with larger cohorts and long-term follow-up are needed to assess clinical potential and safety (42).

Airway stenting in cats is feasible and documented, but remains rare, and typically reserved for advanced airway disease, such as severe tracheal collapse or tracheal obstruction (11, 50). It should be emphasized, however, that metallic stents were used in these cases. No documented use of bioresorbable airway stents in cats was identified during the preparation of this manuscript. Cats have small and delicate airways, which makes stent placement technically challenging. Therefore, stenting is generally applied as an emergency or palliative procedure, particularly when conservative treatment fails.

In horses, airway obstruction is primarily treated surgically, with procedures such as laryngoplasty for laryngeal paralysis, ventriculectomy, soft palate surgery, and laser surgery performed via endoscopy. Conservative management is also used, including anti-inflammatory therapy, bronchodilators, treatment of underlying infections, and environmental modifications. These approaches are considered standard and are often effective (12, 14, 53, 54). Consequently, airway stenting in horses is rare and largely experimental. It is a niche procedure, used in severe and treatment-resistant cases, such as tracheal collapse (10, 62). In both of these reports, metallic stents were used. To date, there are no published reports describing the clinical use of bioresorbable stents in the respiratory tract of horses in the veterinary literature.

Implantation of bioresorbable stents in the digestive system of dogs, cats, and horses

in the digestive system, bioresorbable stents have been applied to treat oesophageal strictures in small animals. In a cat with a post-dental cervical esophageal stricture refractory to balloon dilation, placement of a biodegradable polydioxanone self-expanding stent resulted in resolution of regurgitation, weight gain, and complete stent resorption by four months, with authors suggesting earlier stent placement may reduce procedural burden and cost (3).

A tubular biodegradable stent made from poly(ε-caprolactone-co-DL-lactide) (PCLA) was evaluated in terms of its mechanical properties, shape memory behavior, and the effects of degradation on shape recovery and radial force. In a canine model, the stent recovered its original shape at body temperature, restoring a near-circular configuration and providing support to the esophageal wall. The authors suggest that biodegradable polymer stents may offer a promising alternative to traditional metallic stents in the treatment of esophageal stenosis (67).

Beyond the oesophagus, PLLA-based bioresorbable stents have also been investigated in canine bile ducts. A balloon-expandable PLLA Z-stent demonstrated good biocompatibility, minimal obstruction or migration, and predictable degradation over nine months, with only mild inflammatory changes (64). Similarly, a helical PLLA stent maintained biliary patency after ductal reconstruction in dogs, showing no significant inflammation or hyperplasia and exhibiting favorable integration and functionality (32). These findings suggest that PLLA-based bioresorbable stents are feasible and biocompatible in veterinary models; however, further optimization is required. There is a lack of clinical studies evaluating bioresorbable stents in the equine gastrointestinal tract.

Implantation of bioresorbable cardiovascular stents in dogs, cats, and horses

Bioresorbable stents in the canine vascular system have been investigated, but their use remains limited and far less established than that of permanent metallic stents. Metallic stents have already been applied in the caudal vena cava and used in the treatment of pulmonary artery stenosis and cor triatriatum dexter (5, 6, 18, 34, 37, 44). In contrast, bioresorbable stents in dogs remain at an experimental stage of research.

The authors evaluated a biodegradable nanofiber-covered stent (BDNCS) for carotid artery aneurysms in 17 Beagle dogs. The device consisted of a laser-cut cobalt-chromium stent, a PLA/PCL nanofiber membrane, and a balloon catheter. Technical success was achieved in all cases, with complete aneurysm occlusion in 76.5% immediately and 87.5% at three months. Mild in-stent stenosis was observed in several animals, and one death occurred post-procedure, indicating feasibility but the need for longer-term evaluation (60).

A biodegradable magnesium alloy stent (BMAS) was also tested in the coronary and femoral arteries of 35 dogs to assess safety and efficacy. Angiographic follow-up showed maintained vessel patency without thrombosis or elastic recoil. The stent was fully absorbed within seven days, with moderate intimal hyperplasia observed at 14 days. Overall, BMAS demonstrated good biocompatibility and promising performance as a temporary vascular implant (68).

To date, no clinical reports have described the use of bioresorbable stents in feline or equine cardiology. The available evidence is more limited than in dogs. Metallic stents have been used as palliative treatment for severe pulmonic stenosis in two cats, and in one horse for a post-traumatic pseudoaneurysm of the cavernous internal carotid artery (17, 26).

Implantation of bioresorbable stents in the urinary tract of dogs, cats, and horses

Obstruction of the urinary tract is the second most common indication for stent placement in veterinary medicine. Stents are primarily used in the management of urolithiasis, ureteral strictures, ureteral tears, and urethral strictures (2, 4, 21, 59, 64). The composition of uroliths varies between species. In dogs and cats, the most common types are calcium oxalate and struvite, although risk factors differ, with diet and breed playing significant roles (7, 24, 28, 38, 49). Dalmatian dogs are predisposed to uric acid urolith formation due to a genetic defect in purine metabolism (41). In horses, urolithiasis is less common and is most frequently associated with calcium carbonate uroliths (13, 36).

Consequently, several experimental and preclinical studies in canine models have evaluated the safety, biocompatibility, and degradation profiles of bioresorbable urinary stents. A pilot study investigated a self-reinforcing polylactide (SR-PLA 96) spiral ureteral stent in 16 dogs undergoing unilateral ureteral transection and repair. The contralateral ureters received either a double-J stent or served as controls. Both stent types were well tolerated, inducing only minimal inflammatory changes, including mild ureteral wall edema and epithelial alterations. These reactions subsided following degradation of the SR-PLA stent, and the authors concluded that the device was highly biocompatible, biodegradable, and eliminated the need for removal (30).

In a comparative study, biodegradable self-reinforced polyglycolic acid (SR-PGA) and polylactic acid (SR-PLA) spiral stents were evaluated against stainless-steel stents in the canine uroepithelium and prostate. Mild to moderate inflammation was observed in the biodegradable groups at early time points, whereas stainless-steel stents induced more pronounced fibrosis, chronic inflammation, and epithelial erosion. Overall, histopathological changes associated with SR-PGA and SR-PLA stents were mild, decreased over time, and confirmed good biocompatibility (40).

Further research extended to the urethral model, where polydioxanone (PDO) biodegradable stents were implanted in the proximal and distal urethra of dogs. The stents were technically easy to place and well tolerated throughout the follow-up period. Although progressive granulation tissue formation was observed, it did not lead to clinically significant obstruction, and urethral patency was maintained over 12 weeks, supporting acceptable inflammatory response and functional performance of the material (39).

Additional studies have focused on ureteral injury repair using biodegradable stents. A polylactic acid-based ureteral stent was compared with conventional double-J stents in dogs undergoing ureteroureteral anastomosis. The biodegradable stent fully degraded within 120 days, prevented hydronephrosis and hydroureter, and showed no calcification, whereas double-J stents were associated with mineral deposition. Histological outcomes were comparable between groups, suggesting potential advantages of biodegradable devices in ureteral reconstruction (15).

More recently, a gradient-degradable ureteral stent composed of a magnesium alloy core coated with poly-L-lactic acid (PLLA) and poly(lactic-co-glycolic acid) (PLGA) was evaluated in a beagle model. The device demonstrated drainage efficacy comparable to conventional stents, while exhibiting improved biocompatibility and antibacterial properties. *In vivo* assessments confirmed progressive degradation and acceptable safety profiles, indicating its potential as a promising alternative to biostable ureteral stents (22).

In horses, two case reports have described the use of bioresorbable urethral stents. In the first case, a 12-year-old Thoroughbred stallion developed a urethral stricture secondary to a previous urolith removal procedure. A polydioxanone bioresorbable stent was implanted, resulting in the restoration of spontaneous urination within 13 days, although urine flow initially remained reduced. Progressive epithelialisation of the stent was observed, with partial resorption at 70 days and complete resorption by 155 days. At 20-month follow-up, normal urethral patency and micturition were confirmed (52).

In the second case, a 10-year-old Irish Sport Horse gelding presented with dysuria and pollakiuria associated with cystitis, sand accumulation, and urethral stricture. After failure of conservative management, a custom-made polydioxanone stent was placed under imaging guidance. Normal urination and complete bladder emptying were restored. Follow-up at six months confirmed complete stent resorption with maintained urethral patency, and at 19 months the horse remained clinically normal and in athletic work (2).

These cases suggest that bioresorbable urethral stents may represent a safe and effective treatment option for equine urethral strictures, although standardized protocols for implantation and long-term evaluation are still lacking. No clinical reports on the use of bioresorbable stents in the feline urinary system have been published to date.

Based on the available literature, bioresorbable stents represent a developing area in veterinary medicine, with research primarily focused on dogs and, to a much lesser extent, on cats and horses. In the respiratory system, their application remains largely experimental. Initial studies in canine models demonstrate technical feasibility and short-term biocompatibility of materials such as PLLA, although complications like granulation tissue formation and mechanical injury may occur. In cats and horses, airway stenting is rare and typically relies on metallic devices, with no documented clinical use of bioresorbable alternatives.

In the digestive system, bioresorbable stents have shown promising results, particularly in the treatment of esophageal strictures in dogs and cats, where they can reduce clinical signs and eliminate the need for removal. Experimental studies in canine bile ducts also indicate good biocompatibility and predictable degradation profiles. However, clinical outcomes remain variable, and evidence in horses is lacking.

Cardiovascular applications of bioresorbable stents are still in early experimental stages, mainly in canine models. Studies involving biodegradable polymer- and magnesium-based stents suggest good short-term efficacy and vessel patency, although issues such as intimal hyperplasia and limited long-term data persist. No clinical use has been reported in cats or horses.

The urinary system currently represents the most advanced field for bioresorbable stent application in veterinary medicine. Numerous canine studies demonstrate good biocompatibility, effective drainage, and gradual degradation without the need for removal. Additionally, case reports in horses indicate that bioresorbable urethral stents can successfully restore urinary function with favorable long-term outcomes. In contrast, there is a lack of clinical data in cats. Table 2 provides a summary of bioresorbable stents based on the articles included in this review.

Further research is needed to optimize stent materials and improve their mechanical properties, particularly in terms of durability, controlled degradation, and bio-

Tab. 2. Overview of bioresorbable stents in the included studies

Material	Animal species	Implantation site	Degradation	Outcomes
PLLA	Dog	Trachea	Not specified	Successful deployment, mucosal coverage, one case of granulation tissue and tracheal injury
PDO	Cat	Esophagus	~4 months	Resolution of regurgitation, weight gain, good clinical outcome
PCLA	Dog	Esophagus	Not specified	Good shape recovery, restored lumen, promising results
PLLA Z-stent	Dog	Bile duct	~9 months	Good biocompatibility, minimal inflammation, no migration
PLLA helical stent	Dog	Bile duct	Not specified	Maintained patency, good integration, no significant inflammation
PLA/PCL nanofiber-covered stent (BDNCS)	Dog	Carotid artery	Not specified	High aneurysm occlusion, mild stenosis, one mortality
Magnesium alloy stent (BMAS)	Dog	Coronary and femoral arteries	~7 days	Maintained patency, no thrombosis, moderate intimal hyperplasia
SR-PLA 96	Dog	Ureter	Gradual	High biocompatibility, minimal inflammation, no need for removal
SR-PGA/SR-PLA stents	Dog	Uroepithelium/prostate	Gradual	Mild inflammation, better than stainless steel, good biocompatibility
PDO	Dog	Urethra	Not specified (~12 weeks observation)	Good tolerance, maintained patency, non-obstructive granulation tissue
PLA	Dog	Ureter	~120 days	Prevented hydronephrosis, no calcification; comparable to double-J stents
Mg alloy + PLLA/PLGA coating	Dog	Ureter	Progressive	Good drainage, antibacterial, improved biocompatibility
PDO	Horse	Urethra	~155 days	Restored urination, long-term patency (20 months)
PDO	Horse	Urethra	~6 months	Normal urination, full recovery, long-term success

compatibility. Large-scale clinical trials and long-term studies are essential to confirm safety and efficacy, as well as to establish standardized treatment protocols across different species and clinical indications. Moreover, expanding research to include feline and equine patients is crucial, as current evidence is heavily based on canine models. Broader investigation will support more reliable clinical translation and facilitate wider adoption of bioresorbable stents in veterinary practice.

References

1. *Athanasiou K. A., Agrawal C. M., Barber F. A., Burkhart S. S.*: Orthopaedic applications for PLA-PGA biodegradable polymers. Arthroscopy 1998, 14, 726-737.
2. *Baltrimaite M., Kearney C., O'Brien A., Duggan M., Cuq B.*: Treatment of a urethral stricture by image-guided placement of a custom-made absorbable stent in a standing, sedated horse. J. Vet. Intern. Med. 2024, 38, 2795-2800.
3. *Battersby I., Doyle R.*: Use of a biodegradable self-expanding stent in the management of a benign oesophageal stricture in a cat. J. Small Anim. Pract. 2010, 51, 49-52.
4. *Berent A. C., Weisse C., Beal M. W., Brown D. C., Todd K., Bagley D.*: Use of indwelling double-pigtail stents for treatment of malignant ureteral obstruction in dogs: 12 cases (2006-2009). J. Am. Vet. Med. Assoc. 2011, 238, 1017-1025.
5. *Bertolini G., Caldin M.*: Percutaneous cava stenting in a dog with symptomatic azygos continuation of the caudal vena cava. Case Rep. Vet. Med. 2020, 2020, 7523247.
6. *Borgeat K., Gomart S., Kilkenny E., Chanoit G., Hezzell M. J., Payne J. R.*: Transvalvular pulmonic stent angioplasty: procedural outcomes and complications in 15 dogs with pulmonic stenosis. J. Vet. Cardiol. 2021, 38, 1-11.
7. *Cannon A. B., Westropp J. L., Ruby A. L., Kass P. H.*: Evaluation of trends in urolith composition in cats: 5,230 cases (1985-2004). J. Am. Vet. Med. Assoc. 2007, 231, 570-576.
8. *Cardoso D. R., Barros A., Meneses A., Requicha J. F.*: Biodegradable stents in companion animals: a systematic scoping review. Vet. Med. Int. 2025, 26, 2025-6405530.
9. *Cho D. Y., Lim D. J., Mackey C., Skinner D., Weeks C., Gill G. S., Hergenrother R. W., Swords W. E., Woodworth B. A.*: Preclinical therapeutic efficacy of the ciprofloxacin-eluting sinus stent for Pseudomonas aeruginosa sinusitis. Int. Forum Allergy Rhinol. 2018, 8, 482-489.
10. *Couëtil L. L., Gallatin L. L., Blevins W., Khadra I.*: Treatment of tracheal collapse with an intraluminal stent in a miniature horse. J. Am. Vet. Med. Assoc. 2004, 225, 1727-1732.
11. *Culp W. T., Weisse C., Cole S. G., Solomon J. A.*: Intraluminal tracheal stenting for treatment of tracheal narrowing in three cats. Vet. Surg. 2007, 36, 107-113.
12. *Dean P. W.*: Upper airway obstruction in performance horses. Vet. Clin. North Am. Equine Pract. 1991, 7, 123-148.
13. *Duesterdieck-Zellmer K. F.*: Equine urolithiasis. Vet. Clin. North Am. Equine Pract. 2007, 23, 613-629.
14. *Fenger C. K., Kohn C. W.*: Tracheal obstruction from tracheal collapse associated with pneumonia in a horse. J. Am. Vet. Med. Assoc. 1992, 200, 1698-1700.
15. *Fu W. J., Wang Z. X., Li G., Cui F. Z., Zhang Y., Zhang X.*: Comparison of a biodegradable ureteral stent versus the traditional double-J stent for the treatment of ureteral injury: an experimental study. Biomed. Mater. 2012, 7, 065002.
16. *Gao R., Yang Y., Han Y., Huo Y., Chen J., Yu B., Su X., Li L., Kuo H. C., Ying S. W., Cheong W. F., Zhang Y., Su X., Xu B., Popma J. J., Stone G. W., ABSORB China Investigators.*: Bioresorbable vascular scaffolds versus metallic stents in patients with coronary artery disease: ABSORB China Trial. J. Am. Coll. Cardiol. 2015, 1, 66, 2298-2309.
17. *Gonzalez-Cantero J. L., Del Valle Diéguez M., Monteserín Matesanz C., Saura Lorente J., Villoria Medina F., Fortea Gil F., Castro Reyes E.*: Equine pericardium-covered stenting in carotid pseudoaneurysm. Interv. Neuroradiol. 2018, 24, 635-638.
18. *Graczyk S., Pasławski R., Grzeczka A., Litwińska L., Jagielski D., Pasławska U.*: Stents in veterinary medicine. Materials (Basel) 2023, 16, 1480.
19. *Graczyk S., Pasławski R., Grzeczka A., Pasławska U., Świeczko-Żurek B., Malisz K., Popat K., Sionkowska A., Golińska P., Rai M.*: Antimicrobial and antiproliferative coatings for stents in veterinary medicine. Materials (Basel) 2023, 16, 6834.
20. *Hagiwara H., Hiraishi Y., Terao H., Hirai T., Sakaoka A., Sasaki M., Murota S., Inoue K., Kimura J.*: Vascular responses to a biodegradable polymer (polylactic acid) based biolimus A9-eluting stent in porcine models. EuroIntervention 2012, 8, 743-751.
21. *Haleblian G., Kijvikai K., de la Rosette J., Preminger G.*: Ureteral stenting and urinary stone management: a systematic review. J. Urol. 2008, 179, 424-430.

22. *Jin L., Yao L., Zhou Y., Dai G., Zhang W., Xue B.*: Investigation of a novel gradient degradable ureteral stent in a Beagle dog model. J. Biomater. Appl. 2018, 33, 466-473.
23. *Johnson L. R., Pollard R. E.*: Tracheal collapse and bronchomalacia in dogs. J. Vet. Intern. Med. 2010, 24, 298-305.
24. *Kennedy A. J., White J. D.*: Feline ureteral obstruction: a case-control study. J. Feline Med. Surg. 2022, 24, 298-303.
25. *Kotsar A., Nieminen R., Isotalo T., Mikkonen J., Uurto I., Kellomäki M., Talja M., Moilanen E., Tammela T. L.*: Preclinical evaluation of new indomethacin-eluting biodegradable urethral stent. J. Endourol. 2012, 26, 387-392.
26. *Kyan A., Phipps K., Allen J.*: Transvalvular pulmonary stent angioplasty in cats. J. Vet. Cardiol. 2026, 64, 48-54.
27. *Laaksovirta S., Isotalo T., Talja M., Välimaa T., Törmälä P., Tammela T. L.*: Interstitial laser coagulation and biodegradable self-expandable, self-reinforced poly-L-lactic and poly-L-glycolic copolymer spiral stent in the treatment of benign prostatic enlargement. J. Endourol. 2002, 16, 311-315.
28. *Lekcharoensuk C., Lulich J. P., Osborne C. A., Pusoonthornthum R., Allen T. A., Koehler L. A., Urlich L. K., Carpenter K. A., Swanson L. L.*: Patient and environmental factors in canine calcium oxalate urolithiasis. J. Am. Vet. Med. Assoc. 2000, 217, 515-519.
29. *Liu X., Li F., Ding Y., Zou T., Wang L., Hao K.*: Intelligent optimization of the film-to-fiber ratio of a degradable braided bicomponent ureteral stent. Materials (Basel) 2015, 8, 7563-7577.
30. *Lumiaho J., Heino A., Pietiläinen T., Ala-Opas M., Talja M., Välimaa T., Törmälä P.*: The morphological, in situ effects of a self-reinforced bioabsorbable polylactide (SR-PLA 96) ureteric stent; an experimental study. J. Urol. 2000, 164, 1360-1363.
31. *Martins J. A., Lach A. A., Morris H. L., Carr A. J., Mouthuy P. A.*: Polydioxanone implants: A systematic review on safety and performance in patients. J. Biomater. Appl. 2020, 34, 902-916.
32. *Meng B., Wang J., Zhu N., Meng Q. Y., Cui F. Z., Xu Y. X.*: Study of biodegradable and self-expandable PLLA helical biliary stent in vivo and in vitro. J. Mater. Sci. Mater. Med. 2006, 17, 611-617.
33. *Mittleman E., Weisse C., Mehler S. J., Lee J. A.*: Fracture of nitinol stent in dog. J. Am. Vet. Med. Assoc. 2004, 225, 1217-1221.
34. *Morgan K. R. S., Stauthammer C. D., Gruenstein D.*: Transmembrane stent placement for Cor Triatriatum Dexter in six dogs. J. Vet. Cardiol. 2022, 41, 79-87.
35. *Nakazawa G., Finn A. V., John M. C., Kolodgie F. D., Virmani R.*: The significance of preclinical evaluation of sirolimus-, paclitaxel-, and zotarolimus-eluting stents. Am. J. Cardiol. 2007, 100, 36-44.
36. *Neumann R. D., Ruby A. L., Ling G. V., Schiffman P., Johnson D. L.*: Ultrastructure of urinary calculi in horses. Am. J. Vet. Res. 1994, 55, 1357-1367.
37. *Oliveira P., Domenech O., Silva J., Vannini S., Bussadori R., Bussadori C.*: Retrospective review of congenital heart disease in 976 dogs. J. Vet. Intern. Med. 2011, 25, 477-483.
38. *Osborne C. A., Lulich J. P., Kruger J. M., Ulrich L. K., Koehler L. A.*: Analysis of 451,891 canine uroliths, feline uroliths, and feline urethral plugs from 1981 to 2007: perspectives from the Minnesota Urolith Center. Vet. Clin. North Am. Small Anim. Pract. 2009, 39, 183-197.
39. *Park J. H., Song H. Y., Shin J. H., Kim J. H., Jun E. J., Cho Y. C., Kim S. H., Park J.*: Polydioxanone biodegradable stent placement in a canine urethral model: analysis of inflammatory reaction and biodegradation. J. Vasc. Interv. Radiol. 2014, 25, 1257-1264.e1.
40. *Pétas A., Kärkkäinen P., Talja M., Taari K., Laato M., Välimaa T., Törmälä P.*: Effects of biodegradable self-reinforced polyglycolic acid, poly-DL-lactic acid and stainless-steel spiral stents on uroepithelium after Nd:YAG laser irradiation of the canine prostate. Br. J. Urol. 1997, 80, 903-907.
41. *Roch-Ramel F., Wong N. L., Dirks J. H.*: Renal excretion of urate. Am. J. Physiol. 1976, 231, 326-331.
42. *Saito Y., Minami K., Kaneda H., Okada T., Maniwa T., Araki Y., Imamura H., Yamada H., Igaki K., Tamai H.*: New tubular bioabsorbable knitted airway stent: feasibility assessment for delivery and deployment in a dog model. Ann. Thorac. Surg. 2004, 78, 1438-1440.
43. *Schleich S., Kronen P., Krivitsky A., Paunović N., Brian C. F., Karol A. A., Geks A., Bao Y., Leroux J. C., von Rechenberg B., Franzen D., Klein K.*: Effects of shape and structure of a new 3D-printed personalized bioresorbable tracheal stent on fit and biocompatibility in a rabbit model. PLoS One 2024, 19, e0300847.
44. *Schreiber N., Toaldo M. B., Wolfer N., Dennler M., Corona D., Henze I., Kovacevic A., Glaus T.*: Long-term palliation of right-sided congestive heart failure after stenting a recurrent Cor Triatriatum Dexter in a 10½-year-old Pug. J. Vet. Cardiol. 2022, 41, 121-127.
45. *Shakya A. K., Al-Sulaibi M., Naik R. R., Nsairat H., Suboh S., Abulaila A.*: Review on PLGA polymer based nanoparticles with antimicrobial properties and their application in various medical conditions or infections. Polymers (Basel) 2023, 15, 3597.
46. *Shi J., Lv Y., Yu L., Zhang B., Zhang X., Fan C., Geng Z.*: Interest of a new biodegradable stent coated with paclitaxel on anastomotic wound healing after biliary reconstruction. Eur. J. Gastroenterol. Hepatol. 2013, 25, 1415-1423.
47. *Song R., Murphy M., Li C., Ting K., Soo C., Zheng Z.*: Current development of biodegradable polymeric materials for biomedical applications. Drug Des. Dev. Ther. 2018, 12, 3117-3145.
48. *Stone G. W., Kereiakes D. J., Gori T., Metzger D. C., Stein B., Erickson M., Torzewski J., Kabour A., Piegari G., Cavendish J., Bertolet B., Stockelman K. A., West N. E. J., Ben-Yehuda O., Choi J. W., Marx S. O., Spertus J. A., Ellis S. G., ABSORB IV Investigators.*: 5-year outcomes after bioresorbable coronary scaffolds implanted with improved technique. J. Am. Coll. Cardiol. 2023, 82, 183-195.
49. *Syme H. M.*: Stones in cats and dogs. Arab J. Urol. 2012, 10, 230-239.
50. *Tanaka M., Uemura A.*: Self-expanding tracheal stent in cat. Vet. Med. Sci. 2022, 8, 1347-1351.
51. *Torii S., Yamamoto A., Yoshikawa A., Lu L., Sasaki M., Obuchi S., Wada A., Tsukamoto H., Nakazawa G.*: Magnesium alloy scaffold degradation. Cardiovasc. Interv. Ther. 2024, 39, 428-437.
52. *Trela J. M., Dechant J. E., Culp W. T., Whitcomb M. B., Palm C. A., Nieto J. E.*: Use of an absorbable urethral stent for the management of a urethral stricture in a stallion. Vet. Surg. 2016, 45, O41-O48.
53. *Tucker M. L., Wilson D. G., Bergstrom D. J., Carmalt J. L.*: Computational fluid dynamic analysis of upper airway procedures in equine larynges. Front. Vet. Sci. 2023, 10, 1139398.
54. *Tucker M. L., Wilson D. G., Bergstrom D. J., Carmalt J. L.*: Treatments for equine laryngeal hemiplegia. Front. Vet. Sci. 2024, 11, 1478511.
55. *Uurto I., Juuti H., Parkkinen J., Kellomäki M., Keski-Nisula L., Nevalainen T., Törmälä P., Salenius J. P.*: Requirements for quantitative analysis of intimal reaction in arteries treated with intraluminal stents. J. Endovasc. Ther. 2003, 10, 1110-1116.
56. *Uurto I., Kotsar A., Isotalo T., Mikkonen J., Martikainen P. M., Kellomäki M., Törmälä P., Tammela T. L. J., Talja M., Salenius J. P.*: Tissue biocompatibility of new biodegradable drug-eluting stent materials. J. Mater. Sci. Mater. Med. 2007, 18, 1543-1547.
57. *Vayshbeyn L. I., Mastalygina E. E., Olkhov A. A., Podzorova M. V.*: PLA-based blends review. Appl. Sci. 2023, 13, 5148.
58. *Vieira Costa A., Costa Vieira J., Guedes R., Marques A.*: Degradation and viscoelastic properties of PLA-PCL, PGA-PCL, PDO fibres. Mater. Sci. Forum 2010, 636-637, 825-832.
59. *Voss E. D., Taylor D. S., Slovis N. M.*: Temporary ureteral stent in mare. J. Am. Vet. Med. Assoc. 1999, 214, 1523-1526.
60. *Wang J. B., Zhou B., Gu X. L., Li M. H., Gu B. X., Wang W., Li Y. D.*: Treatment of a canine carotid artery aneurysm model with a biodegradable nanofiber-covered stent: a prospective pilot study. Neurol. India 2013, 61, 282-287.
61. *Wi J., Choi J., Lee S. H.*: PLA-based biodegradable polymer. Polymers (Basel) 2025, 18, 121.
62. *Wong D. M., Sponseller B. A., Riedesel E. A., Couëtil L. L., Kersh K.*: The use of intraluminal stents for tracheal collapse in two horses: Case management and long-term treatment. Equine Vet. Edu. 2008, 20, 80-90.
63. *Woodruff M. A., Hutmacher D. W.*: The return of a forgotten polymer-Polycaprolactone in the 21st century. Prog. Polym. Sci. 2010, 35, 1217-1256.
64. *Wormser C., Clarke D. L., Aronson L. R.*: Outcomes of ureteral surgery and ureteral stenting in cats: 117 cases (2006-2014). J. Am. Vet. Med. Assoc. 2016, 248, 518-525.
65. *Yamamoto K., Yoshioka T., Furuichi K., Sakaguchi H., Anai H., Tanaka T., Morimoto K., Uchida H., Kichikawa K.*: Experimental study of poly-L-lactic acid biodegradable stents in normal canine bile ducts. Cardiovasc. Intervent. Radiol. 2011, 34, 601-608.
66. *Yang W., Ge J., Liu H., Zhao K., Liu X., Qu X., Li W., Huang Y., Sun A., Zou Y.*: Arsenic trioxide eluting stent reduces neointima formation in a rabbit iliac artery injury model. Cardiovasc. Res. 2006, 72, 483-493.
67. *Yu X., Wang L., Huang M., Gong T., Li W., Cao Y., Ji D., Wang P., Wang J., Zhou S.*: A shape memory stent of poly(ε-caprolactone-co-DL-lactide) copolymer for potential treatment of esophageal stenosis. J. Mater. Sci. Mater. Med. 2012, 23, 581-589.
68. *Yue Y., Wang L., Yang N., Huang J., Lei L., Ye H., Ren L., Yang S.*: Effectiveness of biodegradable magnesium alloy stents in coronary artery and femoral artery. J. Interv. Cardiol. 2015, 28, 358-364.
69. *Zaid M. S., Berent A. C., Weisse C., Caceres A.*: Feline ureteral strictures: 10 cases (2007-2009). J. Vet. Intern. Med. 2011, 25, 222-229.
70. *Zhang M. Q., Zou T., Huang Y. C., Shang Y. F., Yang G. G., Wang W. Z., Zhou J. M., Wang L., Chen F., Xie H.*: Braided thin-walled biodegradable ureteral stent: preliminary evaluation in a canine model. Int. J. Urol. 2014, 21, 401-407.
71. *Zhu Y., Yang K., Cheng R., Xiang Y., Yuan T., Cheng Y.*: The current status of biodegradable stent to treat benign luminal disease. Materials Today 2017, 20, 516-529.

Author's address: Joanna Skonieczna-Kurpiel, DVM, PhD, Norwida 31, 50-375 Wrocław, Poland; e-mail: joanna.skonieczna-kurpiel@upwr.edu.pl