

# Efficacy of autologous, homologous, and heterologous blood serums in healing of chemically induced corneal ulcers in dogs: a clinical and ultrasonographic study

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Article Info	Abstract
<b>Article history:</b> Received: 12 August 2025 Accepted: 15 November 2025 Available online: 15 June 2026	<p>Corneal ulcers, particularly from alkaline chemical injuries, are a leading ocular complication in animals, accounting for about 20.00% of emergency referrals. These burns damage the conjunctiva and cornea, causing deep ulcers, potential perforation, delayed healing, infections and blindness. Prompt treatment is crucial to accelerate healing and minimize complications like permanent opacity. This study compared the efficacy of blood serums (autologous, homologous, and heterologous) against standard treatment (N-acetylcysteine and ciprofloxacin eye drops) and a control group (Normal saline) in treating induced corneal ulcers in five groups consisting of 10 healthy mixed-breed female dogs. Ulcers were created using 3.00 M sodium hydroxide-soaked filter paper on both eyes. Evaluations on 1, 7, 14, and 21 days assessed quantitative parameters (Total corneal and stromal thickness, ulcer diameter) and qualitative symptoms (photophobia, blepharospasm, discharge, congestion, edema, neovascularization, opacity) via ultrasonography and clinical exams, respectively. Results showed significant time- and treatment-dependent improvements. Heterologous serum notably reduced thickness and ulcer diameter from day seven compared to others. By days 14 - 21, all treatments (serums and drugs) lowered stromal thickness versus control. Qualitative parameters were improved significantly with all treatments from day seven. These findings supported the use of blood-derived serums, especially heterologous serum, to accelerate healing and improving clinical outcomes in canine corneal ulcers.</p>
<b>Keywords:</b> Corneal ulcer Dog Serum therapy Ultrasound	

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## Introduction

The cornea serves as a critical ocular structure, providing a smooth, transparent surface that enables the orderly passage of light into the eye. Damage to this avascular, hypocellular layer impairs its transparency and protective function. Various pathogens, including bacteria, viruses, parasites and fungi can induce severe corneal infections with histopathological analysis revealing immune cells such as neutrophils, lymphocytes, monocytes and macrophages in the stroma.<sup>1</sup> As the eye outermost component, the cornea is susceptible to external traumas causing abrasions, lacerations and other injuries that may lead to visual impairment. Corneal ulcers are the most prevalent ocular complication.<sup>2</sup> In companion animals, traumatic corneal ulcers are a major concern in veterinary ophthalmology; untreated cases risk progressing to visual disturbances, ocular perforation and blindness from secondary infections. Ulcers affecting the epithelial and stromal layers often stem from eyelid,

eyelash or tear film dysfunction, manifesting as pain, blepharospasm, photophobia, epiphora, conjunctival hyperemia and corneal edema.<sup>3</sup> Chemical-alkaline injuries pose a severe, vision-threatening risk, comprising about 20.00% of emergency referrals.<sup>4</sup> Alkaline ocular burns deplete limbal stem cells, delaying or preventing epithelialization. Non-healing epithelial defects may arise from conditions like keratoconjunctivitis sicca, exposure keratopathy, neurotrophic keratitis, stem cell deficiency or post-infectious ulcers. In dogs, chemical injuries present with pain, tear film instability, ulceration, edema and neovascularization.<sup>2</sup> Intraocular sequelae include hypopyon, hyphema, ciliary body inflammation and lens epithelial opacity/edema. Alkaline injuries predominate over acidic ones in dogs due to alkalis in pet products like shampoos, damaging epithelium, basement membrane, keratocytes, nerves, endothelium and episclera.<sup>5</sup> These often result in deep ulcers and perforation.<sup>6</sup> Collagenase activity drives rapid stromal melting in such ulcers, necessitating infection control and lytic enzyme inhibition.

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Effective anti-collagenase agents include acetylcysteine, cysteine, progesterone, medroxyprogesterone, sodium citrate, sodium ascorbate, tetracyclines, thiol peptides, ethylenediaminetetraacetic acid variants, penicillamine, heparin and blood serum.<sup>7</sup> Acetylcysteine is a synthetic derivative of the amino acid cysteine, distinct from the naturally occurring compound and is favored for stability and availability but requires refrigeration, frequent dosing, exhibits poor stromal penetration and has relative toxicity. Side effects are typically mild, such as nausea and vomiting, however, a severe allergic reaction is a rare risk, especially with intravenous administration.<sup>6</sup> Blood serum inhibits collagenase via proteins like alpha-1-antitrypsin and alpha-2-macroglobulin. Alpha-1-antitrypsin, synthesized mainly in the liver and present in fluids like tears, and alpha-2-macroglobulin, a broad-spectrum inhibitor, target multiple proteinases. Growth factors (e.g., platelet-derived, beta, vascular endothelial, fibroblast, insulin-like, epidermal) enhance wound healing.<sup>8</sup> Autologous serum eye drops pioneered blood-derived treatments for corneal injuries, shortening healing time and improving quality via components like albumin and immunoglobulins.<sup>9</sup> Topical serum on abrasions releases growth factors from platelet lysis during centrifugation.<sup>10</sup> Corneal ulcers, especially alkaline-induced, provoke intense inflammation inhibiting epithelial growth and causing fibrosis/scarring. Post-injury, cells divide and recruit immune effectors, leading to edema, however, basement membrane disruption hinders reattachment.<sup>11</sup> Ulceration elevates degradative proteinases, hence, disrupting matrix components with alkaline burns causing deep damage.<sup>12</sup> Pathological states increase oxidative stress and autologous serum antioxidant and anti-inflammatory properties mitigate this.<sup>13,14</sup> This study aimed to compare clinically and ultrasonographically the effects of autologous, homologous and heterologous serums versus conventional treatment (N-acetylcysteine and ciprofloxacin) on induced corneal ulcers in dogs using ultrasound and direct observation.

## Materials and Methods

This study was conducted in accordance with institutional and international ethical code: IR-UU-AEC-3/61 and guidelines for animal research, emphasizing the principles of replacement, reduction, and refinement. Ten dogs (mixed-breed female, aged approximately 2 - 5 years and weighing 25.00 - 30.00 kg) were divided to five groups in which both eyes ( $n = 4$ ) were included in this study. The mean measurement or score of each animal, was used for statistical analysis. Experimental animals were selected based on the absence of prior systemic or ophthalmic diseases, confirmed through clinical examinations, complete blood counts, deworming, and vaccination.

They were housed individually with *ad libitum* access to commercial dry adult dog food (Aromatisch, Aromatisch Pet Nutrition, Tehran, Iran) and water, acclimatized for 1 week, and randomly assigned to five treatment groups ( $n = 2$  per group). On the 1<sup>st</sup> day of the experiment, and prior to the induction of chemical corneal ulcers, all dogs were anesthetized by intramuscular injection of 10.00 mg kg<sup>-1</sup> ketamine (Bremer Pharma, Warburg, Germany) and 0.10 mg kg<sup>-1</sup> acepromazine (Alfasan, Woerden, The Netherlands). The dogs received autologous serum (G1), homologous serum from another dog (G2), heterologous serum from a rabbit (G3), standard treatment with N-acetylcysteine (Exir Pharmaceutical Co., Tehran, Iran) that was prepared as a 2.50% ophthalmic solution plus ciprofloxacin (Sina Darou, Karaj, Iran) and administered into the affected eye as one drops every 4 hours (G4), or control group (G5). Serums were prepared by collecting blood every 3 days via jugular venipuncture, clotting at 22.00 °C, centrifuging at 160 *g* for 10 min and storing at 4.00 °C for up to 72 hr. Solutions were refreshed similarly. Baseline ocular health was assessed via examinations, ultrasonography, Schirmer tests (Madhu Instruments Pvt. Ltd, New Delhi, India) and fluorescein staining. Under general anesthesia, bilateral corneal ulcers were induced using 3.00 M NaOH (Mercks, Darmstadt, Germany)-soaked 8.00 mm Whatman disks (Whatman, Maidstone, UK) applied for 1 min, followed by debridement, 2-min saline irrigation, fluorescein confirmation, flunixin meglumine (Rooyan Darou, Tehran, Iran) was administered intramuscularly at a dose of 1 mg kg<sup>-1</sup> once daily for 3 days, and Elizabethan collars placement. Treatments (2 drops per eye every 3 hr from 8:00 AM to 8:00 PM) started 4 hr post-induction, with adjunctive 1.00% atropine (Sina Darou, Karaj, Iran) twice daily for 7 days, in all dogs. Evaluations on days one, seven, 14, and 21 included ultrasonographic measurements of corneal and stromal thickness, anterior chamber clarity and checks for uveitis or cataracts, plus clinical assessments of ulcer diameter (mm; measured using a digital Vernier caliper, Mitutoyo Corp., Kawasaki, Japan). The ultrasound device used in this study was model S40, SonoScape Co., Ltd., Shenzhen, China. An IA12 probe with a frequency of 9.00 - 17.00 MHz was employed for all evaluations. Ulcer severity was scored on a 0 - 5 scale, where 0 = no ulcer, 1 = minimal superficial ulcer, 2 = mild stromal involvement, 3 = moderate stromal ulcer, 4 = deep stromal ulcer approaching Descemet's membrane and 5 = full-thickness ulcer/perforation.<sup>15</sup> Additional clinical signs (including photophobia, discharge, hyperemia, chemosis, opacity, edema, neovascularization, and pigmentation) were graded from absent to severe.

**Statistical analysis.** Quantitative data were analyzed factorially (five treatments × four-time intervals points) in a randomized design and mean comparisons were made using the Duncan's Multiple Range Test and non-

parametric data via Kruskal-Wallis, and perforation differences via Fisher's exact test, using the SAS Software (version 9.4; SAS Institute, Cary, USA) appropriate software for means ± SD or medians. A *p*-value less than 0.05 was considered statistically significant. The clinicians who performed the clinical and ultrasonographic evaluations were blinded to the treatment groups to minimize observer bias.

**Results**

**Quantitative parameters.** Corneal thickness was significantly influenced by time (*p* < 0.05), treatment (*p* < 0.01) and their interaction (*p* < 0.01; Table 1). This influence was manifested as a reduction in corneal thickness in the treated groups compared to the control group (normal saline). Specifically, while no significant differences were observed on days one and seven, the homologous serum, heterologous serum and conventional drug treatments all significantly decreased corneal thickness compared to the untreated control by day 14. By day 21, all treatment groups including autologous, homologous and heterologous serum as well as conventional drugs showed a significant reduction in corneal thickness compared to the control group. The

lowest corneal thickness was recorded in the homologous serum group on day 21 (0.97 mm), while the highest was in the control group on the same day (2.25 mm; Table 2).

The lowest mean corneal thickness (0.97 mm) was recorded for the homologous serum treatment on day 21, while the highest (2.25 mm) was observed in the control group (untreated ulcer) on day 21 (Table 2; Fig. 1). Stromal thickness was significantly affected by treatment (*p* < 0.01) and the time × treatment interaction (*p* < 0.01; Table 1). The highest stromal thicknesses were in the control group on days 21 (1.52 mm) and 14 (1.39 mm), respectively, with no significant difference between them. The lowest stromal thickness of 0.47 mm was observed using standard treatment (N-acetylcysteine and ciprofloxacin) on day 14. No significant difference was found between this value and that of G3 on day seven, those of G2, G3 and G4 on day 14, and all four treatment groups on day 21. No significant differences were found in terms of stromal thickness between control and treatments on day one. On day seven, heterologous serum reduced stromal thickness compared to other treatments, and standard treatment (N-acetylcysteine and ciprofloxacin) reduced it compared to the control group. On days 14 and 21, all four treatments significantly reduced stromal thickness versus the control group.

**Table 1.** Analysis of variance for quantitative traits assessed.

Sources of variation	Degrees of freedom	Corneal thickness	Stromal thickness	Ulcer diameter
Treatment	4	0.98**	1.11**	1.20**
Time	3	0.24**	0.17*	1.66**
Treatment × Time	12	0.27**	0.16**	0.21**
Experimental error	60	0.04	0.046	0.004
Mean	-	1.32	0.83	0.39
Coefficient of variation (%)	-	15.10	25.70	16.96

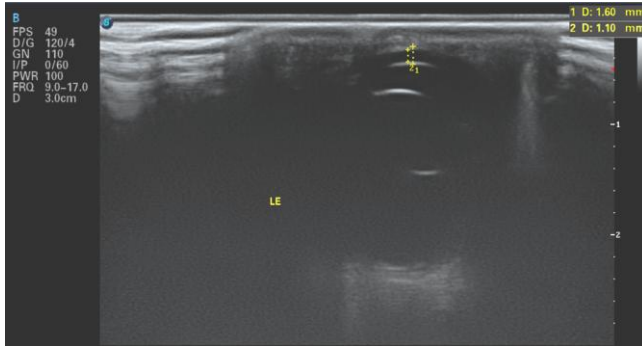
\* and \*\*: Significant at *p* < 0.05 and *p* < 0.01, respectively.

**Table 2.** Comparison of means for the interaction effects of time × treatment on quantitative traits.

Time	Treatment groups	Corneal thickness (mm)	Stromal thickness (mm)	Ulcer diameter (mm)
Day 1	Autologous therapy group	1.61 <sup>a</sup>	0.93 <sup>a</sup>	8.00 <sup>a</sup>
	Homologous therapy group	1.50 <sup>a</sup>	0.96 <sup>a</sup>	8.00 <sup>a</sup>
	Heterologous therapy group	1.37 <sup>a</sup>	0.90 <sup>a</sup>	8.00 <sup>a</sup>
	Standard treatment	1.49 <sup>a</sup>	0.92 <sup>a</sup>	8.00 <sup>a</sup>
	Negative control	1.38 <sup>a</sup>	1.02 <sup>a</sup>	8.00 <sup>a</sup>
Day 7	Autologous therapy group	1.35 <sup>a</sup>	0.89 <sup>abc</sup>	0.80 <sup>b</sup>
	Homologous therapy group	1.29 <sup>a</sup>	1.00 <sup>ab</sup>	6.80 <sup>a</sup>
	Heterologous therapy group	0.90 <sup>b</sup>	0.49 <sup>c</sup>	1.20 <sup>b</sup>
	Standard treatment	1.29 <sup>a</sup>	0.72 <sup>bc</sup>	1.50 <sup>b</sup>
	Negative control	1.44 <sup>a</sup>	1.19 <sup>a</sup>	8.00 <sup>a</sup>
Day 14	Autologous therapy group	1.43 <sup>a</sup>	0.80 <sup>b</sup>	0.25 <sup>b</sup>
	Homologous therapy group	1.02 <sup>b</sup>	0.54 <sup>bc</sup>	0.25 <sup>b</sup>
	Heterologous therapy group	0.94 <sup>b</sup>	0.55 <sup>bc</sup>	0.00 <sup>b</sup>
	Standard treatment	1.04 <sup>b</sup>	0.48 <sup>c</sup>	0.00 <sup>b</sup>
	Negative control	1.69 <sup>a</sup>	1.39 <sup>a</sup>	0.90 <sup>a</sup>
Day 21	Autologous therapy group	1.25 <sup>b</sup>	0.66 <sup>b</sup>	0.00 <sup>b</sup>
	Homologous therapy group	0.97 <sup>b</sup>	0.56 <sup>b</sup>	0.00 <sup>b</sup>
	Heterologous therapy group	0.95 <sup>b</sup>	0.52 <sup>b</sup>	0.00 <sup>b</sup>
	Standard treatment	1.18 <sup>b</sup>	0.55 <sup>b</sup>	0.00 <sup>b</sup>
	Negative control	2.25 <sup>a</sup>	1.52 <sup>a</sup>	0.95 <sup>a</sup>

<sup>abc</sup> Means with the same letter in a column per time point are not significantly different (Duncan's multiple range test, *p* < 0.05).

Ulcer diameter was significantly influenced by time ( $p < 0.05$ ), treatment ( $p < 0.01$ ), and their interaction ( $p < 0.01$ ; Table 1). The control group exhibited the largest ulcer diameters (0.90 mm) on both days 14 and 21. All four treatments resulted in complete resolution of ulcer diameter by day 21. No significant differences were observed among treatments on day one, however, all four treatments significantly reduced ulcer diameter compared to the control group on days seven, 14, and 21 (Table 2).



**Fig. 1.** Measurement of corneal thickness (# 1) and stromal thickness (# 2) using ultrasonography 1 day after corneal ulcer induction (Day one) - Autologous group. LE: Left Eye.

**Clinical and ultrasonographic parameters.** No significant differences were observed among treatments for any clinical or ultrasonographic parameters on day one. Ultrasonographic examination was used to evaluate the characteristics of the aqueous humor (including clarity, hemorrhage, and debris) as well as the presence of uveitis, secondary cataracts and posterior segment lesions (Table 3). By day seven, significant differences ( $p < 0.05$  or  $p < 0.01$ ) were observed in ulcer severity, photophobia, ocular discharge, conjunctival hyperemia, chemosis and corneal opacity, whereas, no significant changes were noted in edema, neovascularization, abnormal pigmentation, or ultrasonographic findings ( $p > 0.05$ ). Heterologous serum generally yielded the lowest scores for ulcer severity and corneal opacity, while all four treatments reduced photophobia, discharge, hyperemia, and chemosis compared to the control group. Pair-wise comparisons confirmed significant reductions primarily between treatments and the control group, with few differences among treatments. On day 14, all parameters except for abnormal pigmentation showed significant differences ( $p < 0.01$ ). Heterologous and homologous serums had the lowest ulcer severity scores, and all four treatments

reduced scores for photophobia, discharge, hyperemia, chemosis, opacity, edema, neovascularization and ultrasonographic abnormalities (e.g., anterior chamber clarity, uveitis) compared to the control group. Pair-wise tests indicated consistent significance difference between treatments and the control group. On day 21, similar patterns were observed with significant differences ( $p < 0.01$ ) for all parameters except for abnormal pigmentation. Heterologous serum again showed the lowest ulcer severity, and all treatments reduced other clinical signs and ultrasonographic abnormalities relative to the control group with pair-wise differences mainly between treatments and the control. No significant differences were observed in terms of abnormal pigmentation among all time points ( $p > 0.05$ ), indicating no treatment effects.

No side effects were observed during the treatment or even 1 month after the treatment. Furthermore, follow-up conducted more than 1 year after this study revealed no new side effects.

## Discussion

Ultrasonography has emerged as a pivotal diagnostic tool in ophthalmology, particularly for conditions where direct visualization of ocular structures is challenging. Marchini *et al.* conducted a comprehensive study on ultrasonographic findings in patients with endophthalmitis, demonstrating its efficacy in identifying inflammation, abscesses and structural alterations within the eye, especially when media opacities hinder internal examination.<sup>16</sup> This non-invasive technique allows clinicians to assess ocular interiors without surgical intervention, thereby, informing clinical decisions and optimizing treatment strategies. The study suggests that ultrasonography not only enhances diagnostic accuracy but also contributes to improved therapeutic outcomes in endophthalmitis management, positioning it as a valuable asset in ophthalmic practice. Also, these findings underscore the potential for advancing ocular imaging modalities and fostering innovative diagnostic and therapeutic protocols.<sup>16</sup> Ragab and Fathy explored ultrasonography role in veterinary ophthalmology, specifically in canines, where it proved non-invasive and safe for detecting conditions like cataracts, retinal detachment, glaucoma and keratitis. Employing a 10.00 MHz probe yielded high-resolution images of internal eye structures, facilitating precise diagnosis and monitoring of ocular pathologies.

**Table 3.** Non-parametric Kruskal-Wallis analysis for clinical and ultrasound traits.

Time	Wound severity	Photophobia	Ocular discharge	Conjunctival hyperemia	Chemosis	Corneal opacity	Corneal edema	Corneal neovascularization	Ultrasound examination
Day 1	0.00 <sup>ns</sup>	0.00 <sup>ns</sup>	0.00 <sup>ns</sup>	0.00 <sup>ns</sup>	0.00 <sup>ns</sup>	0.00 <sup>ns</sup>	0.00 <sup>ns</sup>	0.00 <sup>ns</sup>	0.00 <sup>ns</sup>
Day 7	11.38*	19.00**	19.00**	19.00**	19.00**	19.00**	0.00 <sup>ns</sup>	0.00 <sup>ns</sup>	0.00 <sup>ns</sup>
Day 14	14.06**	19.00**	19.00**	19.00**	19.00**	19.00**	19.00**	19.00**	19.00**
Day 21	12.50**	19.00**	19.00**	19.00**	19.00**	19.00**	19.00**	19.00**	19.00**

ns: Non-significant; \* and \*\*: Significant at  $p < 0.05$  and  $p < 0.01$ , respectively.

This approach supports enhanced clinical decision-making and better treatment results, as evidenced by its application in the current research for identifying corneal ulcerative lesions and tracking healing progress.<sup>17</sup> Similarly, Kilker *et al.*, highlighted ultrasonography utility in emergency departments, where it enables swift identification of ocular injuries, patient instability assessment and abnormality detection through imaging. Its non-invasive profile is advantageous in resource-limited urgent care settings, potentially streamlining patient management and elevating emergency ophthalmic care standards.<sup>18</sup> Corneal ulcers represent a prevalent ocular ailment, often precipitated by trauma, chemical agents or microbial infections involving viruses, bacteria or chlamydia. Alkaline burns, the most severe chemical injuries, typically carry poor prognoses, inflicting damage on the conjunctiva and cornea, culminating in deep ulcers or perforations. Delayed healing exacerbates risks of infection and blindness with permanent opacity as a minimal repercussion, necessitating prompt interventions to accelerate repair and mitigate complications. Corneal ulcer treatment remains a cornerstone of ophthalmology, given the cornea essential function in vision preservation. Alkaline injuries provoke intense inflammation surpassing traumatic ones, impeding epithelial regeneration and fostering fibrosis or scarring.<sup>19,20</sup> Diverse therapeutic modalities have been scrutinized for corneal ulcer remediation, encompassing amniotic membrane grafts, subconjunctival platelet-rich plasma (PRP) injections, acetylcysteine, umbilical cord serum, honey, propolis extracts, and sodium hyaluronate.<sup>21,22</sup> In human ophthalmology, blood-derived products like autologous serum and platelet-enriched plasma eye drops have gained interest as regenerative alternatives owing to their capacity to expedite tissue healing.<sup>23</sup> The efficacy of autologous serum stems from its protein composition including fibronectin, albumin and epidermal growth factors vital for epithelial restoration post-alkaline injury.<sup>24</sup> Epidermal growth factors have demonstrated benefits in epithelial regeneration across experimental and clinical contexts for alkaline corneal damage.<sup>25</sup> Chemical ocular traumas correlate with diminished antioxidant defenses and heightened lipid peroxidation. Topical antioxidants such as dimethyl-thiourea have shown proficiency in curbing acute corneal inflammation.<sup>26</sup> Günay *et al.* observed elevated antioxidant activity in aqueous humor and cornea treated with autologous serum drops versus controls, suggesting augmented ocular tissue antioxidant capacity.<sup>27</sup> Sherif and Pleyer reported substantial malondialdehyde reductions in treated eyes post-alkaline burns, emphasizing glutathione peroxidase role as a key corneal antioxidant enzyme against peroxides.<sup>28</sup> Post-burn glutathione peroxidase activity declines, yet autologous serum treatment elevates it, indicating restorative effects on peroxide inhibition

systems even after mild injuries.<sup>27,29</sup> Autologous serum applications extend to dry eye management in Sjögren's syndrome, where Tsubota *et al.* noted marked symptom alleviation due to its nutrient and growth factor content aiding ocular surface repair.<sup>10</sup> This safe, effective option for refractory cases highlights personalized therapy value, given inter-individual response variability and serves as a springboard for novel dry eye interventions.<sup>10</sup> In veterinary medicine, corneal ulcers are among the most common ocular conditions in dogs. While superficial ulcers generally heal without significant scarring, deeper lesions carry the risk of adhesions, glaucoma or even vision loss if perforation occurs. Nevertheless, with appropriate treatment, they are highly manageable.<sup>29,30</sup> Anitua *et al.* investigated the use of growth factor-rich autologous serum and plasma for corneal ulcers and ocular surface disorders. Both preclinical and clinical findings demonstrated improved healing, reduced inflammation and accelerated recovery, confirming their therapeutic potential.<sup>23,31</sup> Comparative analyses, such as the current study versus Watal *et al.*, probe corneal ulcer therapies in dogs.<sup>32</sup> The former evaluates blood sera (autologous, homologous, heterologous) and standard drugs, revealing notable decreases in corneal thickness and ulcer dimensions. The latter study focused on ulcers caused by trauma and keratoconjunctivitis sicca in brachycephalic breeds, reporting complete healing of superficial lesions but longer recovery times for deeper ones. Both studies highlighted the importance of individualized treatment approaches and careful monitoring of the healing process.<sup>32</sup> Gadallah *et al.* and the present study both highlighted the therapeutic advantages of blood-derived products in managing canine corneal ulcers.<sup>33</sup> They reported that PRP surpassed autologous serum and control treatments in both the speed and quality of healing which were in agreement with our findings of reduced corneal and stromal thicknesses as well as smaller ulcer diameters when treated with blood-derived therapies and medications compared to controls. While PRP outperformed autologous serum in Gadallah's study, the present research highlighted the superior efficacy of heterologous serum, although PRP was not evaluated. The role of ultrasonography in monitoring is widely recognized, accompanied by calls for further refinement of blood-derived therapies in clinical practice.<sup>33</sup> Shahriari *et al.* reported that 20.00% diluted autologous serum was ineffective in promoting epithelial healing in alkaline ulcers compared to controls, whereas, undiluted serum enhanced healing by providing concentrated growth factors that support cellular proliferation. Absence of perforations in treated groups implies stromal lysis prevention, mirroring the current study undiluted serum outcomes.<sup>34</sup> Contrarily, Campos *et al.*, discerned no healing enhancements with autologous serum in severe sodium hydroxide burns versus saline, lacking clinical or histo-

pathological findings. Yet, the present study achieved full healing by day 14, diverging from prior results.<sup>6</sup> Advancements in corneal evaluation encompass optical coherence tomography, topography and confocal microscopy, as reviewed by Rio-Cristobal and Martin.<sup>35</sup> These enable anomaly pinpointing and treatment customization, with pros, cons and clinical utilities dissected. They aid early detection, progression tracking and outcome appraisal, alongside future development recommendations.<sup>35</sup> The current study innovation lies in comparing blood sera with conventional treatment, particularly evaluating non-autologous (homologous, heterologous) options. Previous studies highlighting the benefits of autologous serum are further expanded by evidence supporting the potential of both homologous and heterologous sera, underscoring the need for broader medical, veterinary and biological research to advance ocular therapeutics. The integration of non-invasive imaging with biologically targeted treatments offers transformative prospects for both human and veterinary ophthalmology, emphasizing the importance of continued empirical investigation to optimize protocols and maximize patient outcomes. In conclusion, the results of this study demonstrated that topical blood-derived serum treatments provided superior and accelerated healing of corneal ulcers compared to conventional chemical drugs, underscoring their therapeutic potential for promoting faster restoration of visual function by supporting corneal tissue regeneration. Importantly, the origin of the serum - whether autologous, homologous, or heterologous- did not significantly affect its therapeutic efficacy as all sources delivered essential growth factors and immunomodulatory components that facilitated healing. Prompt intervention with such biologically active agents is crucial for optimal clinical outcomes.

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### Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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