

Comparative evaluation of autologous platelet-rich plasma and porcine skin bandaging for wound healing in cats

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The study was conducted on 24 apparently healthy adult cats with open wounds, divided equally into two groups: group I treated with porcine skin biological bandage (n=12) and group II treated with autologous platelet-rich plasma (PRP) (n=12) on days 0, 5, and 10. Both groups demonstrated fast granulation and epithelialization. There were no significant differences in mean wound area between the groups on days 0, 5, 10 and 15; however, on day 21, group I showed significant reduction in mean wound area as compared to group II. Further, wound contraction was greater in group I, indicating more effective healing compared to group II. Physiological and haematological parameters remained stable, with no significant variations between groups at different treatment intervals. Overall, the wound healing was rated very good in group I (porcine skin biological bandages) and good in group II (autologous PRP).

Key words: Cat, Platelet rich plasma, Porcine skin, Wound healing, Xenograft

Regenerative medicine is an emerging field dedicated to the repair, replacement, or regeneration of cells, tissues, or organs to restore impaired functions (Pang *et al.*, 2017). One extensively used method in treating various skin wounds is porcine xenografting. Gaining popularity in the 1960s, porcine skin emerged as the most widely utilized xenograft in human medicine (Chiu *et al.*, 2004) for treating variety of skin wounds, including chronic and acute wounds, burns, and partial- or full-thickness skin loss (Chiu *et al.*, 2004; Chairini *et al.*, 2007). These grafts serve as temporary biological dressings that accelerate granulation, neovascularization, and healing. Also, regenerative medicine approaches like platelet-rich plasma (PRP) have shown promise in promoting wound healing (Farghali *et al.*, 2017). PRP is derived from the patient's own blood and is rich in growth factors, which stimulate tissue regeneration.

In veterinary medicine, clinicians often follow similar protocols for wound healing in both dogs and cats. However, it has been observed that prolonged wound healing is more prevalent in cats compared to dogs (Perc and Erjavec, 2022). The inflammatory phase lasts longer in cats than in dogs, possibly delaying proliferation and differentiation phases (Bohling, 2014). Also, there is less formation of granulation

tissue in cats (Bohling *et al.*, 2004). Their skin is looser, more pliable, and more mobile over most of the body surface than canine skin with significant differences exist in cutaneous perfusion (Bohling and Henderson, 2006). Numerous studies have indicated variations in skin perfusion, the macroscopic appearance of wounds, and even microscopic cellular structure between these two species, leading to slower wound healing in cats (Perc and Erjavec, 2022). Currently, there are no studies on the use of porcine skin biological bandaging in cats and only a few studies on the use of PRP in cats. Despite advancements in wound management, there remains a need for comprehensive studies evaluating the efficacy of novel treatments in feline patients. Therefore, by investigating these two regenerative medicine approaches, this study aims to compare the effectiveness of autologous PRP with porcine skin biological bandage in promoting wound healing in cats.

Materials and Methods

The study involved 24 apparently healthy adult cats with open wounds, randomly assigned to two groups of 12 animals each. Group I (n=12) was treated with porcine skin biological bandages, while group II (n=12) received autologous platelet-rich plasma (PRP). Both treatments were administered on days 0, 5, and 10, with the first treatment day designated as day 0, over a 21-day study period.

For use in animals of group I, the porcine skin was collected under aseptic conditions from freshly slaughtered, healthy pigs at a local abattoir in Mumbai. Immediately post-harvest, the skin was placed in sterile plastic bags containing an antibiotic solution (1000 mL saline + 100,000 units/100 mL crystalline penicillin + 80 mg/100 mL gentamicin) and transported in an icebox. In the laboratory, under sterile conditions, the skin was soaked in a 4% lysol solution (0.1% Benzalkonium Chloride) for 15 min to eliminate microbial contaminants. Then, after thorough rinsing with normal saline, uniform-sized bandages were prepared using an electric dermatome

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and stored at -18°C in a cryoprotectant solution of 15% glycerol with buffered saline to prevent ice crystal formation and preserve tissue integrity. The prepared graft was then carefully positioned over the healthy wound bed and secured in place with dry bandages.

For the PRP treatment, blood samples were aseptically collected from the cephalic or saphenous veins of cats in group II animals using 3.2% sodium citrate tubes. The blood was subjected to a two-step centrifugation process (Theresa, 2021). Initially, a "soft spin" was performed at 4000 rpm for 5 min to separate the platelets and plasma from other blood components. The platelet-rich plasma fraction was then carefully transferred to a plain tube and underwent a second centrifugation step, the "hard spin," at 8000 rpm for 10 min to further concentrate the platelets. The resulting PRP was directly injected into the wound bed edges and also applied topically by sprinkling over the wound after wound cleaning and debridement on days 0, 5, and 10. The wounds were then covered with sterile dressings (dry bandage) to protect against contamination and promote healing.

The wound area was digitally measured using the Imito Measure smartphone application (Bodea *et al.*, 2021) on days 0, 5, 10, 15, and 21. Pain, granulation, and epithelialization were also assessed on these days. Percentage wound contraction was calculated (Kodati *et al.*, 2011) and the rate of wound healing was evaluated (Cukjati *et al.*, 2001). Microbial cultures were obtained before treatment and after 21 days. Overall wound healing was assessed, along with heart rate, respiration rate, and rectal temperature on days 0, 8, and 21. Haematological and biochemical parameters, including aspartate aminotransferase (AST), alanine aminotransferase (ALT), alkaline phosphatase (ALP), blood urea nitrogen (BUN), and creatinine, were also measured.

The data were statistically analyzed using a completely randomized design and one-way analysis of variance (ANOVA), paired t-test as per Snedecor and Cochran (1994).

Results and Discussion

The sterilization and preservation method used for porcine skin bandages in group I demonstrated excellent efficacy in terms of biocompatibility, as evidenced by the absence of adverse effects or allergic reactions in the treated cats. In group II, the mean platelet concentration in whole blood was 3.08 ± 0.13 ($\times 10^5/\text{mm}^3$), while in group II it was 24.31 ± 2.1 ($\times 10^5/\text{mm}^3$), representing an 8-fold increase compared to whole blood. According to Saunders *et al.* (2018) and Angelou *et al.* (2022), a substance meets the criteria for PRP if its platelet concentration ranges from 2 to 5 times that of whole blood. In this study, PRP met these criteria and produced satisfactory results in wound

healing.

There were no significant differences in heart rate, respiratory rate, and rectal temperature between and within the groups on days 0, 8, and 21. In group I, elevated temperature was recorded in three cases on day 1 following porcine bandage application, but subsequent applications did not cause temperature elevation. Graft removal is typically necessary if purulence is present underneath or if the patient exhibits unexplained temperature elevation (Silverstein *et al.*, 1972; Paap, 1976). Furthermore, haematological parameters, including Hb, TEC, TLC, PCV, and platelet count, remained stable with no significant changes. Similarly, biochemical parameters such as AST, ALT, ALP, BUN and creatinine levels did not show any significant alterations throughout the observation period.

In groups I and II, wound edges noticeably improved after each bandage placement or PRP application. Group I showed distinct wound margins with significant contraction after the porcine bandage application. In group II, three complicated wounds with detached edges reattached to the wound bed by day 5, indicating effectiveness of the treatment.

In group I, pain significantly reduced from severe to nil, consistent with Papp (1976) and Hobby and Levick (1978). Papp (1976) observed immediate pain relief after applying porcine skin post-debridement, suggesting that this effect could be attributed to the restoration of the normal tissue environment surrounding the sensory nerve endings. The reduction in pain in group II was consistent with findings by Carter *et al.* (2011) and Horgos *et al.* (2023) in human studies. Horgos *et al.* (2023) noted PRP's role in reducing neurological and neuropathic pain.

Enhanced granulation was evident in all cases in both groups. By day 21, most cases achieved 75% to 100% granulation in group I, aligned with Papp (1976), who has reported that split-thickness porcine skin grafts helped control infection in contaminated wounds and stimulated granulation tissue growth and re-epithelialization. Group II results corroborated with Zubin *et al.* (2015), who noted significant granulation tissue formation four days after the initial PRP application. However, our results contradicted Parmar *et al.* (2022), who found no significant granulation after PRP treatment in cats compared to dogs. Overall, superior granulation was observed with both treatments.

In animals of both groups, there was a significant decrease ($P < 0.05$ and $P < 0.01$) in the wound area during the healing period from day 0-21 (Table I). There were no significant differences in mean wound area between the groups on days 0, 5, 10, and 15; but a significant difference was seen on day 21. The mean percentage of wound contraction significantly increased within each group on days 5, 10, 15, and 21 compared to day 0 ($P < 0.01$ at all intervals).

Table I: Mean \pm SE of wound area (cm²) and wound contraction (%) in cats of treatment group I (porcine skin bandaging) and II (PRP application)

Parameter	Group	Days of Treatment				
		Day 0	Day 5	Day 10	Day 15	Day 21
Wound area (cm ²)	I	19.57 \pm 2.57 ^a	14.73 \pm 2 ^b	9.47 \pm 1.28 ^c	5.38 \pm 0.9 ^{cd}	1.89 \pm 0.53 ^d
	II	20.1 \pm 4.64 ^a	16.06 \pm 3.83 ^{ab}	13.15 \pm 3.29 ^{abc}	9.26 \pm 2.38 ^{bc}	6.19 \pm 1.68 ^c
Wound contraction (%)	I	0	25.08 \pm 0.83 ^{a*}	53.25 \pm 1.95 ^{a*}	73.67 \pm 1.48 ^{a*}	90.58 \pm 1.78 ^{a*}
	II	0 ^e	20.83 \pm 1.23 ^d	37 \pm 3.08 ^c	56.41 \pm 3.78 ^b	69.67 \pm 3.59 ^a

Means with different superscripts within the row differ significantly between time intervals (P<0.05).

Additionally, there was a significant difference (P<0.05 and P<0.01) in wound contraction percentage between the groups on these days.

Group I showed significantly faster wound

contraction and epithelialization, with a notable decrease in wound area on days 5, 10, 15, and 21, and a shorter healing duration compared to group II. By days 15 and 21, most cases achieved 75-100%



Group I: day 0



Group I: day 5



Group I: day 10



Group I: day 15



Group I: day 21



Group II: day 0



Group II: day 5



Group II: day 10



Group II: day 15



Group II: day 21



Group II: day 60

epithelialization. The significant reduction in wound area in this group is attributed to marked wound contraction and improved re-epithelialization under the porcine bandages, which create a natural wound environment, acting as both skin substitute and collagen prosthesis (Chiu and Burd, 2004).

In group II, the progressive reduction in wound area was statistically significant ($P < 0.05$), indicating the beneficial effect of PRP on wound healing (Table I). PRP is rich in growth factors and cytokines crucial for tissue repair. It stimulates cell proliferation, promotes angiogenesis, and enhances collagen synthesis, essential for the healing process (Smith *et al.*, 2007). By day 21, epithelialization reached 50-75% in most cases, improving progressively with each PRP application. Re-epithelialization, involving the proliferation and differentiation of epidermal cells, relies on various growth factors like VEGF, EGF, FGF, TGF- β , PDGF, and IGF-1, each playing critical roles. PRP can stimulate tissue cells to produce these factors via autocrine or paracrine mechanisms, particularly EGF and TGF- β (Xu *et al.*, 2020). However, PRP demonstrated slower epithelialization and wound contraction compared to group I.

The mean duration of healing was 28.08 ± 1.89 in group I and 45.75 ± 5.23 days in group II. A shorter duration of healing was observed in group I, which is consistent with the findings by Burleson and Eiseman (1972), Papp (1976), and Chiu and Burd (2005), all of them have reported a decrease in healing duration following porcine graft application. The mean rate of wound healing was 0.082 ± 0.006 cm/day in group I and 0.051 ± 0.003 cm/day in group II, with group I showing a significantly higher healing rate. Pig skin facilitates quicker healing by creating an environment that promotes epithelial cell migration and proliferation (Hosseini *et al.*, 2009). In group II, quicker wound contraction was observed on days 5, 10, 15, and 21 with PRP application, but delayed healing was observed after the completion of the treatment regimen. The slower healing rate might be due to larger wound sizes in some cases and instances of self-trauma in a few individuals. Also, large open wounds in cats often exhibit a slower rate of healing (Bohling *et al.*, 2004; Perc and Erjavec, 2022). This finding aligned with that of Zubin *et al.* (2015) regarding the gradual decrease in growth rate after the completion of the PRP treatment regimen.

Localized infection with microorganisms such as Staphylococcus, Streptococcus, and E. coli was initially observed in both groups but resolved by day 21, with no microorganisms isolated thereafter. PRP contains antimicrobial peptides like defensins, crucial for host defense and exhibiting bactericidal properties (Vladulescu *et al.*, 2024). Porcine skin grafts act as a physical barrier to bacteria, minimizing infection risk in contaminated wounds (Papp, 1976; Davis and Arpey, 2000; Hosseini *et al.*, 2009). It also contains

inherent antimicrobial peptides and proteins that inhibit bacterial growth on wound surfaces (Zhang *et al.*, 2000). Both treatments demonstrated effective antibacterial activity, promoting a healthy wound environment conducive to healing.

From the results of this study, it can be concluded that the porcine skin bandage group demonstrated quicker wound contraction, increased epithelialization and faster rate of healing with significantly shorter healing duration as compared to the PRP group, indicating its superior efficacy in promoting wound healing. Overall, wound healing outcomes were very good with porcine skin biological bandages (group I) and good with autologous PRP (group II).

References

- Angelou, V., Psalla, D., Dovas, C.I., Kazakos, G.M., Marouda, C., Chatzimisios, K., Kyra, Z., Moutou, E., Karayannopoulou, M. and Papazoglou, L.G., 2022. Locally injected autologous platelet-rich plasma improves cutaneous wound healing in cats. *Animals* **12**: 1993.
- Bodea, I.M., Dirlea, S.A., Mureşan, C., Fiş, N.I. and Beteg, F.I. 2021. Clinical benefits of using a smartphone application to assess the wound healing process in a feline patient—a case report. *Topics Companion Anim. Med.* **42**: 100498.
- Bohling, M.W., Henderson, R.A., Swaim, S.F., Kincaid, S.A. and Wright, J.C. 2004. Cutaneous wound healing in the cat: a macroscopic description and comparison with cutaneous wound healing in the dog. *Vet. Surg.* **33**: 579-587.
- Bohling, M.W. and Henderson, R.A. 2006. Differences in cutaneous wound healing between dogs and cats. *Vet. Clin. North Am. Small Anim. Pract.* **36**: 687-692.
- Bohling, M.W. 2014. Wound healing. *In: Feline Soft Tissue and General Surgery*, Langey-Hobbs, S.J., Demetriou, J.L. and Ladlow, J.F. (Eds). *Velika Britanija: Elsevier Ltd.*
- Burleson, R. and Eiseman, B. 1973. Mechanisms of antibacterial effect of biologic dressings. *Ann. Surg.* **177**: 181-186.
- Carter, M.J., Fylling, C.P. and Parnell, L.K. 2011. Use of platelet rich plasma gel on wound healing: a systematic review and meta-analysis. *Eplasty* **11**.
- Chiarini, A., Dal Pra, I. and Armato, U. 2007. In vitro and in vivo characteristics of frozen/ thawed neonatal pig split-skin strips: A novel biologically active dressing for areas of severe, acute or chronic skin loss. *Int. J. Mol. Med.* **19**: 245-255.
- Chiu, T. and Burd, A. 2005. "Xenograft" dressing in the treatment of burns. *Clin. Dermatol.* **23**: 419-423.
- Chiu, T., Pang, P., Ying, S.Y. and Burd, A. 2004. Porcine skin: friend or foe? *Burns* **30**: 739-741.
- Cukjati, D., Reberšek, S. and Miklavèè, D. 2001. A reliable method of determining wound healing rate. *Med. Biol. Eng. Comput.* **39**: 263-271.
- Davis, D.A. and Arpey, C.J. 2000. Porcine heterografts

- in dermatologic surgery and reconstruction. *Dermatol. Surg.* **26**: 76-80.
- Farghali, H.A., AbdElKader, N.A., Khattab, M.S. and AbuBakr, H.O. 2017. Evaluation of subcutaneous infiltration of autologous platelet-rich plasma on skin-wound healing in dogs. *Biosci. Reports* **37**: BSR20160503.
- Hobby J.A.E. and Levick, P.L. 1978. Clinical evaluation of porcine xenograft dressings. *Burns* **4**: 188-192.
- Horgos, M.S., Pop, O.L., Sandor, M., Borza, I.L., Negrean, R.A., Cote, A., Neamtu, A.A., Grierosu, C., Sachelarie, L. and Huniadi, A. 2023. Platelets rich plasma (PRP) procedure in the healing of atonic wounds. *J. Clin. Med.* **12**: 3890.
- Hosseini, S.N., Mousavinasab, S.N., Rahmanpour, H. and Fallahnezhad, M. 2009. A biological dressing versus 'conventional' treatment in patients with massive burns: a clinical trial. *Turkish J. Trauma Emerg. Surg.* **2**: 135-140.
- Kodati, D.R., Burra, S. and Kumar, G.P. 2011. Evaluation of wound healing activity of methanolic root extract of *Plumbagozeylanica* L. in wistar albino rats. *Asian J. Plant Sci. Res.* **1**: 26-34.
- Pang, C., Ibrahim, A., Bulstrode, N.W. and Ferretti, P. 2017. An overview of the therapeutic potential of regenerative medicine in cutaneous wound healing. *Int. Wound J.* **14**: 450-459.
- Papp, G.M. 1976. The use of porcine skin in partial and full-thickness skin loss. *J. Am. Osteopathic Assoc.* **75**: 951-957.
- Parmar, J.J., Mecvan, A., Shah, A., Rao, N. and Hadiya, K. 2022. Application of autologous platelet rich plasma in a wound management in animals. *Indian J. Anim. Res.* DOI: 10.18805/IJAR.B-4942
- Perc, B. and Erjavec, V. 2022. Overview of wound healing differences between dogs and cats. *Proc. Socrat. Lect.* **7**: 167-171.
- Saunders, W.B., Bearden, R.N. and Franklin, S.P. 2018. Platelet-rich plasma and autologous conditioned sera. *In: Veterinary Surgery Small Animal*, Johnston, S.A. and Tobias, K.M. (Eds), Vol, 1, 2nd edn. Elsevier, St Louis, MO, USA. pp 40-48.
- Silverstein, P., Warden, G.D., Salisbury, R.E. and McManus, W.F. 1972. Continued evaluation of split-thickness cutaneous xenograft as a temporary biologic wound cover for use in burned soldiers. Brooke Army Medical Center-Annual Progress Report.
- Smith, R.G., Gassmann, C.J. and Campbell, M.S. 2007. Platelet-rich plasma: properties and clinical applications. *J. Lancaster General Hosp.* **2**: 73-77.
- Snedocor and Cochran, 1994. *Statistical Methods*, 8th edn. East West Press, New Delhi.
- Theresa, N. 2021. Platelet-rich plasma technique for wound healing in different canine wounds. Master's thesis submitted to Lebanese university, Faculty of Agricultural Engineering and Veterinary Medicine.
- Vladulescu, D., Scurtu, L.G., Simionescu, A.A., Scurtu, F., Popescu, M.I. and Simionescu, O. 2024. Platelet-rich plasma (PRP) in dermatology: cellular and molecular mechanisms of action. *Biomed.* **12**: 7.
- Xu, P., Wu, Y., Zhou, L., Yang, Z., Zhang, X., Hu, X., Yang, J., Wang, M., Wang, B., Luo, G. and He, W. 2020. Platelet-rich plasma accelerates skin wound healing by promoting re-epithelialization. *Burns and Trauma*, **8**, tkaa028.
- Zhang, G., Ross, C. and Blecha, F. 2000. Porcine antimicrobial peptides: new prospects for ancient molecules of host defense. *Vet. Res.* **31**: 277-296.
- Zubin, E., Conti, V., Leonardi, F., Zanichelli, S., Ramoni, R. and Grolli, S. 2015. Regenerative therapy for the management of a large skin wound in a dog. *Clin. Case Rep.* **3**: 598.