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Clinical evaluation of subdermal skin flaps for reconstruction of extensive skin defects in dog

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Abstract

The present study was undertaken on sixteen dogs to evaluate the clinical application and outcomes of subdermal skin flap techniques for the reconstruction of defects following wide surgical excision of cutaneous and subcutaneous tumours in dogs. The subdermal skin flap techniques were selected based on defect location, size, and availability of adjacent skin. Diagnostic procedures included fine needle aspiration cytology, histopathology to rule out the nature of the tumour and thoracic radiography for evaluating pulmonary metastasis. Surgical excision of tumours followed by flap reconstruction was successfully performed in all cases, achieving adequate defect coverage. Postoperative physiological parameters showed mild transient elevation, while haematological and biochemical changes remained within normal limits, except for a temporary increase in serum alkaline phosphatase. Wound healing and cosmetic outcome were achieved satisfactorily, with no tumour recurrence during the one-month follow-up period. Complications such as suture dehiscence and distal flap necrosis were observed in a few cases. This study concluded that the subdermal skin flap is a simple and effective technique for reconstruction of extensive skin defects in the management of both benign and malignant skin tumours.

Keywords: Subdermal skin flaps, reconstruction, cutaneous tumours, advancement flap, transpositional flap, rotational flap

1. Introduction

The skin is frequently exposed to environmental factors such as UV radiation, chemicals, and pathogens, making it prone to cancer development. Cutaneous tumours are a significant concern in dogs due to their prevalence and impact on quality of life. These tumours range from benign to highly malignant forms and often require a comprehensive treatment approach. Wide surgical excision is essential for malignant tumours to minimize local recurrence, but it often results in large skin defects that cannot be closed primarily due to excessive tension. This challenge is further complicated in cases with ulceration, infection, necrosis, or myiasis, where extensive debridement increases defect size.

Reconstructive surgery is therefore crucial in veterinary oncology to achieve effective wound closure, restore function, and improve cosmetic outcomes. In areas with limited skin availability, techniques such as skin flaps and grafts are commonly employed to facilitate healing by primary intention Tobias (2010) ^[22]. The selection of an appropriate flap depends on factors like skin availability, elasticity, and local tissue condition, with donor sites ideally allowing tension-free closure Ragni & Moore (2008) ^[17]. Additionally, successful reconstruction requires evaluation of surgical variables such as incision technique, wound tension, and site-specific applicability Rappaport *et al.* (1990) ^[18]. The subdermal skin flap technique involves transposition of skin and subcutaneous tissue while preserving the subdermal plexus, ensuring adequate blood supply and reducing the risk of flap necrosis. The present study aims to clinically evaluate this technique for reconstructing large post-tumour excision defects in dogs, with an emphasis on functional and cosmetic outcomes.

2. Materials and Methods

The present study was conducted on sixteen dogs with cutaneous and subcutaneous tumours presented to the Veterinary Clinical Complex, Post Graduate Institute of Veterinary and Animal Sciences Akola, Maharashtra from February 2025 to January 2026, which were treated by wide surgical excision followed by skin reconstruction using different subdermal skin flaps. The cases were divided into two groups based on anatomical location: Group I ($n = 8$): Head, neck, and thorax Group II ($n = 8$): Abdomen, limb, and perineum. Age, breed, sex, and body weight of the animal were recorded for all patients.

The physiological assessment includes heart rate (beats/min.), respiration rate (breaths/min.) and rectal temperature ($^{\circ}\text{F}$) were recorded on the 0th, 3rd and 7th postoperative days. Clinical evaluation was performed to evaluate the location, size, consistency, multiple growths, ulcerated or infected surface of the growth, along with the assessment of nearby lymph nodes.

Fine Needle Aspiration Cytology (FNAC) was performed on the day of presentation. Haematological estimations including Haemoglobin (g/dL), Packed Cell Volume (%), Total Erythrocyte Count ($\times 10^6/\text{cubic mm}$), Total Leucocyte Count ($\times 10^3/\text{cubic mm}$), and Differential Leucocyte Count (%) was done at 0th, 3rd and 7th day postoperatively. In biochemical estimations, Alkaline Phosphatase (ALP) (U/L), Total Protein (g/dL), and Calcium (mg/dL) were evaluated on the day of the surgical procedure and at intervals on the 3rd and 7th days post-operatively. Histopathological evaluation was also done to rule out the nature of growth. Skiagrams of the thorax were obtained in all cases to rule out possible pulmonary metastasis. An ultrasound examination was performed to examine the primary organs to aid in the diagnosis of cases involving metastasis.

3. Intraoperative evaluation

A) Anaesthesia

Dogs of both groups were preanaesthetised using a combination of Inj. Atropine Sulphate @ 0.02 mg/kg subcutaneously, Inj. Xylazine @ 1 mg/kg + Inj. Butorphanol @ 0.2 mg/kg intramuscularly. Anaesthetic induction was carried out using Inj. Midazolam @ 0.2 mg/kg and Inj. Propofol @ 4 mg/kg intravenously. Maintenance of anaesthesia was undertaken either using Inj. Propofol @ 2 mg/kg intravenously or inhalant anaesthesia 2% Isoflurane.

B) Surgical Technique

Large skin defects after tumour excision were reconstructed using single pedicle advancement flap (SPAF), bipedicle advancement flap (BAF), transpositional flap (TF) and rotational flap (RF) according to the defect size, anatomical location of the tumours, and the amount of adjacent loose skin available for flap creation. An incision was made in the skin according to the contour of the tumours, ensuring a minimum margin of 2 cm that was measured and marked with a sterile scale and skin marker, followed by careful dissection of the subcutaneous fascia and subcutaneous fat. Suitable skin flaps were designed and incised. Undermining was done meticulously to conserve the subdermal plexus. The flaps were initially secured using simple continuous sutures subcutaneously with Vicryl 2-0 and simple interrupted or cruciate mattress sutures with 2-0 monofilament nylon. In cases where considerable dead space remained, indwelling drains were placed to facilitate proper drainage.

C) Intraoperative observations

Observations recorded during the surgical procedure were adequacy of flap for coverage, presence of tension at the subdermal skin flap suture line, creation of dog ears and time taken for the surgical procedure.

D) Postoperative evaluation of flap healing

Flap condition, dead space, infection, discharge, suture dehiscence and wound healing time were recorded on the 0th, 3rd, 7th, and 14th postoperative day using the Southampton wound grading system Adhikari *et al.* (2025) [1], functional and aesthetic outcomes of the flap after healing were recorded, complications like flap necrosis, suture dehiscence, seroma formation and recurrence of growth were recorded and treated accordingly.

3.1 Statistical analysis

The data collected was statistically analyzed by using the online software WASP-2 by ICAR.

4. Results and Discussion

In the present study, cutaneous and subcutaneous tumours were observed in dogs ranging from 3 to 15 years of age, with a mean age of 8.32 ± 2.54 years. The highest tumour incidence was recorded in middle-aged dogs between 5-10 years (75%; $n = 12$), followed by dogs older than 10 years (18.75%; $n = 3$) and those younger than 5 years (6.25%; $n = 1$). The results of the present study are in agreement with earlier reports by Butler *et al.* (2013) [3] and Simkus *et al.* (2016) [20] who observed that skin tumours occurred most frequently in dogs aged 6-8 years.

Among the 16 clinical cases, Labrador Retrievers showed the highest incidence (37.50%; $n = 6$), followed by non-descript dogs (31.25%; $n = 5$). German Shepherds and Pomeranians each accounted for 12.50% ($n = 2$), while Rottweiler showed the lowest incidence (6.25%; $n = 1$). Group-wise analysis indicated that Labradors were most commonly affected in group I (37.50%; $n = 3$), whereas non-descript dogs predominated in group II (50.00%; $n = 4$). These findings are concurrent with Butler *et al.* (2013) [3] and Disha *et al.* (2025). Sex-wise distribution of tumours in the present study showed no marked overall sex predilection. In group I, male dogs were more commonly affected (62.50%; $n = 5$) than females (37.50%; $n = 3$), whereas in group II, females predominated (62.50%; $n = 5$) compared to males (37.50%; $n = 3$) (Martin *et al.*, 2022; Kashyap *et al.*, 2013) [6, 7]. The mean values of rectal temperature, heart rate, and respiration rate were slightly elevated due to post-surgical stress but remained within normal physiological limits, indicating minimal systemic involvement.

Tumour location varied distinctly between the two groups. In group I ($n = 8$), tumours were predominantly located on the thorax (50.00%), followed by the head region (37.50%) and neck (12.50%). In contrast, group II ($n = 8$) showed a higher involvement of the abdominal region (62.50%), including urethral and mammary tumours, followed by the perineal region (25.00%) and hind limb (12.50%). Overall, group I exhibited a predominance of thoracic tumours, whereas group II showed a higher incidence of abdominal tumours Mukaratirwa *et al.*, 2005; Athira *et al.*, 2024) [14, 2]. Tumours in group II were larger and more variable in size (7.75 ± 3.19 cm) compared to group I (5.13 ± 1.96 cm), indicating relatively advanced tumour growth in group II. Oval sessile tumours predominated in group I, whereas group II showed

equal distribution of tumour shapes, reflecting greater morphological variability, particularly in mammary gland tumours. Most tumours in both groups were ulcerated, likely due to chronicity and surface friction, while bleeding was notably observed in mast cell tumours. With respect to consistency, group I tumours were predominantly firm to hard, whereas group II showed a higher proportion of soft tumours, suggesting differences in tumour texture between groups Mathew *et al.* (2022) ^[11]. Regional lymph nodes were largely normal in both groups, with lymph node enlargement observed in a small proportion of cases, more frequently in group II. Overall, limited lymphatic involvement was evident at presentation, although isolated lymph node enlargement may indicate localized inflammatory response or early metastatic spread Horbe *et al.* (2025) ^[5]. Fine needle aspiration cytology demonstrated marked heterogeneity in tumour origin across both groups ($n = 16$). Overall, mesenchymal tumours and mast cell tumours were the most prevalent neoplastic conditions, (31.25% each). Transmissible venereal tumours were identified in 3 cases (18.75%), while epithelial neoplasms, including three cases of malignant epithelial tumours (18.75%), these observations are similar to those of Johnson and Myers (2017) ^[6]. Haematological parameters such as haemoglobin, total erythrocyte count, packed cell volume showed decline on 3rd post-operative day which can be attributed to intra-operative blood loss. Pusp *et al.* (2023) ^[16] also found a significant decrease in haemoglobin observed during the surgery across all groups. total leucocyte count, differential leukocyte count, remained within normal limits, with transient deviations attributed to surgical stress, inflammatory response and tumour physiology. Biochemical analysis revealed that serum alkaline phosphatase values showed a mild increase in the postoperative period, likely associated with tissue healing and inflammatory response. Serum calcium and total protein values were non-significant and remained within physiological limits throughout the post-operative period. Histopathological examination of tumours from both groups ($n = 16$) revealed a mixed spectrum of benign and malignant neoplasms. However, malignant tumours predominated, accounting for 10 cases (62.5%), while benign tumours comprised 6 cases (37.5%).

Thoracic radiographic examination revealed that the majority of dogs exhibited either normal lung patterns (37.50%; $n = 6$) or mild interstitial lung changes (43.75%; $n = 7$). A broncho-interstitial lung pattern was observed in 12.50% of cases ($n = 2$), while pulmonary metastasis was detected in only one case (Figure 1) (6.25%), which involved a mammary tumour.



Fig 1: Multiple pulmonary nodules scattered in the lungs, indicating pulmonary metastasis in the case of mammary tumor

Pulmonary metastasis in the mammary tumour case is consistent with the known metastatic pattern of malignant canine mammary tumours, which commonly spread to the lungs via lymphatic and hematogenous routes, particularly in high-grade or advanced lesions Leksmi *et al.* (2021). Overall, 81.25% of the dogs ($n = 13$) showed either normal lungs or mild interstitial changes. Abdominal ultrasonographic examination did not reveal metastatic lesions in any of the cases (0%; $n = 16$), indicating minimal systemic spread at the time of presentation.

5. Intraoperative evaluation

Surgical excision of tumours followed by reconstruction using subdermal skin flaps was successfully performed in all cases (100%; $n = 16$) by using single pedicle advancement flap (Figure 2) in $n = 3$, bipedicle advancement flap (Figure 3) in $n = 4$, transpositional flap in $n = 5$ (Figure 4) and rotational flap (Figure 5) in $n = 4$. Also, adequate skin defect coverage was achieved in every case (100%). With respect to skin tension, no tension was observed in 5 cases (31.25%), mild tension in 5 cases (31.25%), moderate tension in 4 cases (25.0%), and severe tension in 2 cases (12.5%), with variation depending on the type of flap used and anatomical location of the defect. Dog ear formation was observed in 6 cases (37.5%), while it remained absent in the majority of cases (62.5%; $n = 10$). The mean surgical time recorded for all cases was 72.2 minutes, indicating that tumour resection and subdermal skin flap creation were relatively time-consuming but technically feasible procedures. Surgical resection followed by skin flap reconstruction was a relatively time-consuming procedure (Salvatori *et al.*, 2016; Marsh *et al.*, 2016) ^[19, 9].



Fig 2: (Left to right); Case 5 of Group I

A) Skin flap design for SPAF B) Final outcome



Fig 3: (Left to right); Case 8 of Group-I

A) Skin flap design for DPAF B) Final outcome

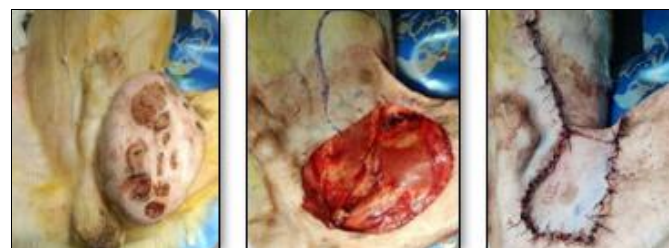


Fig 4: (Left to right); Case 4 of Group II

A) Tumor with ulcerated surface B) Transpositional Flap marking C) Final outcome



Fig 5: (Left to right) Case 3 of Group II A) Skin defect after bilateral radical mastectomy B) Rotational Flap marking C) Final outcome

5.1 Postoperative evaluation of flap healing

Post-operative flap evaluation revealed discharge in 7 cases (43.75%), including purulent, serosanguinous, haemoserous, or serous types, while 9 cases (56.25%) showed none. Wound margin abnormalities were noted in 2 cases (12.5%), whereas 14 cases (87.5%) had normal margins. Wound dehiscence occurred in 2 cases (12.5%) and dead space formation in 2 cases (12.5%). Flap motion was present in all cases (100%), indicating adequate mobility.

Wound healing occurred within 10-14 days in 12 cases (75.0%), while 4 cases (25.0%) showed delayed healing (up to 28 days), mainly associated with transposition flaps, tension, contamination, necrosis, and dehiscence. On day 0, all wounds were Grade 0. By day 3, most showed Grade I, with a few Grade II. On day 7, Group I had mainly Grade II-IIIa wounds, while Group II showed relatively severe changes, including one Grade V case. By day 14, most Group I cases improved to Grade 0-I, whereas some Group II cases remained Grade II or higher. Healing outcomes were satisfactory in both groups, with Group II showing a higher proportion of excellent healing and better cosmetic results (Figure 6).



Fig 6: (Left to right) A) Day 3rd haemoserous discharge was observed, B) On Day 14th, sutures were removed C) After one-month showing full hair growth without scar formation

5.2 Complications

Postoperative complications were minimal in both groups. In group I, uncomplicated wound healing was observed in 87.5% ($n = 7/8$) cases, with only one complication (12.5%; $n = 1/8$) involving a transposition flap at the left forehead, which developed infection and distal flap necrosis. In group II, full flap necrosis was also observed in one case of transpositional flap. The wound ultimately healed by secondary intention with scar formation.

6. Conclusion

The present study demonstrated that wide surgical excision followed by reconstruction using subdermal skin flaps is a safe, feasible, and effective technique for the management of cutaneous and subcutaneous tumours in dogs. Most cases showed satisfactory healing within two weeks, with minimal systemic involvement and limited postoperative

complications. Although mild wound complications such as dehiscence and flap necrosis were observed in a few cases, overall cosmetic and functional outcomes were good to excellent. Therefore, subdermal skin flaps can be considered a simple yet reliable reconstructive option for extensive skin defects following tumour resection in canine patients.

Conflict of Interest

The authors do not have any conflicts of interest.

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