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CASE REPORT

MESH SKIN GRAFTS TO MANAGE LIMB WOUNDS: TWO CASE REPORTS

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SUMMARY

A cat and a dog were presented to the University Veterinary Hospital, Universiti Putra Malaysia with de-gloving injuries of the right fore-limb and left hind-limb respectively. The injuries were treated with full-thickness mesh skin grafts. The outcome of the graft in the cat was good with 80% graft 'take' and satisfactory hair growth. In the dog, however, the intended full-thickness mesh graft was instead a split-thickness mesh graft due to the excessive de-fatting during graft preparation. There was 100% graft 'take' but the appearance was unsatisfactory because of the sparse hair re-growth while the grafted skin remained thin and easily traumatised.

Keywords: Skin graft, de-gloving injury, cat, dog

INTRODUCTION

A skin graft is a process in which skin from one area of the body is completely detached and used to resurface another area that lacks skin. It is different from skin flap, which is a partially detached skin where blood circulation is maintained at the distal portion of the flap. In general, skin grafts can be used to close any skin defect that has healthy granulation tissue or tissue with enough vessels to form granulation tissue. Skin grafts are most indicated for reconstruction of skin defects on limbs where there is insufficient adjacent skin available to advance over the defect. De-gloving injury of the extremities is an excellent example (Swaim, 1986; Pope, 1988b).

Skin grafts can be classified according to the thickness of the skin used. A full-thickness skin graft includes both the epidermis and dermis while the partial or split-thickness skin graft consists of epidermis and varying amounts of dermis. This paper reports the outcome of 2 mesh skin grafts that were performed on a cat and a dog.

CASE HISTORY

Case 1 – Full-thickness mesh graft

A 7-month-old male domestic short-hair cat weighing 2.3kg was presented at the University Veterinary Hospital, Universiti Putra Malaysia (UVH-UPM) with a history of being hit by an automobile 24 hours previously. The cat was in shock, severely dehydrated, recumbent and in severe pain. The right forelimb had a large de-gloving injury covering the entire circumference of the limb. There was also severe muscle contusion extending from the radial aspect of the humeral area to the proximal carpus. There were other small areas of skin loss and muscular injury on the flanks, left fore and hind limbs. Radiography revealed a fracture-luxation of the right accessory carpal bone. Increased radiographic density that was observed at the right cranial lung lobe and the loss of detail at the cranial abdomen were most likely due to internal haemorrhage in the thoracic cavity. Clinical pathology showed a mild regenerative anaemia and marked leukocytosis with mild hypoproteinaemia. *Haemobartonella felis* and fleas were present.

Shock was treated with a crystalloid fluid solution (Hartmann's solution; B.Braun) at 60mL/kg/hour for the first hour and hydrocortisone sodium succinate (Solu-Cortef; Upjohn) at 25mg/kg. As the wounds were heavily contaminated, enrofloxacin (Baytril 10%; Bayer) was administered parentally at 10mg/kg soon as the cat appeared stable.

An hour after admission, the cat was sedated with intravenous zolazepam-tiletamine (Zoletil 50; Virbac) at 5mg/kg for wound treatment. Non-viable skin and muscles were excised before the wounds were well irrigated with sterile saline to remove debris. Before bandaging with wet sterile gauze and roller bandage, the raw tissues were dressed with 0.1% gentamicin skin cream (Gentamicin; K.H. Hoe). As the right forepaw was markedly swollen with pitting oedema, six parallel skin incisions, each approximately 1cm long, were made over the dorsal paw and cranial carpus to drain

the oedema fluid.

In the first 5 days of hospitalisation, enrofloxacin and metronidazole (Metronodazole; B. Braun) were administered intravenously at 10mg/kg once daily and twice daily respectively. Daily intramuscular meperidine hydrochloride (Pethidine HCL; Southern Task) injection was required at 5 mg.kg for pain management and for daily application of wet-to-dry bandages.

By day 6 of admission, the cat was alert. Analgesia was no longer required for the daily bandage change. The wet-to-dry dressings were changed to non-adherent dressings so as not to interfere with granulation tissue formation on the wound. The non- adherent dressings consisted of a first layer of chlorhexidine acetate gauze (Bactigrass; Smith&Nephew) followed by a few layers of sterilized gauze held in place with roller bandage. Gentamicin cream dressing on the raw skin was continued. The antibacterials were changed to a daily clavulanic acid-amoxycillin (Clavulox; Pfizer) injection at 8mg/kg once daily. The cat was also given multivitamins, minerals and haematinics to treat anaemia. By day 15 the cat was able to walk on all four limbs but with hyperextension of both right and left carpus. The swelling of the right forepaw was markedly reduced.

A full-thickness mesh skin graft for the right forelimb was carried out on day 22 post-admission. The donor skin was harvested from the left flank. The cat was premedicated with acetylpromazine (Calmivet; Vetoquinol) at 0.1mg/kg and atropine sulfate (Atrosite; Illium) at 0.05mg/kg. Thiopental sodium (Thiopental; Biochemie) at 12.5mg/kg was used for induction. Anaesthesia was then maintained with 2% halothane (Fluothane; Zeneca).

The donor site was routinely shaved and scrubbed with 4% chlorhexidine gluconate (Hibiscrub;Zeneca) followed with 70% alcohol and 1.8% tincture iodine (Tincture Iodine; Lazuli) as final preparation. The recipient site was prepared by copious flushing with sterile normal saline. A template of the recipient site was made with a clean paper towel, which was then transferred to the donor site to outline the area required before the recipient site was flushed again with sterile normal saline.

An extra 1cm wide band of skin around the template was harvested to ensure sufficient skin was available for the graft. The harvested skin was removed close to the dermis to reduce the amount of subcutaneous fat. The skin defect at the donor site was then closed with a combination of vertical mattress and simple interrupted sutures using 3-0 polyprolene (Prolene; Ethicon) and a swedged-on curved cutting needle.

All subcutaneous tissue was removed from the graft with curved Metzenbaum scissors until a 'cobblestone' appearance of hair follicles was seen, then hand meshed by making 1 cm parallel incisions between ½ to 1 cm apart. Handling of the graft was carried out using glove and was rested on moist sterile gauze for meshing. The graft was kept moistened with normal saline during the 2 hours of graft preparation.

Just prior to the graft placement, the recipient site was flushed with normal saline and the granulation tissue was scraped with the tips of a haemostat. There was minimal bleeding and a good haemostasis. Simple interrupted sutures using 3-0 polypropylene were used to tack the graft to the borders of the recipient site while four tacking sutures were placed through the mesh holes to immobilize the graft. The graft was stretched during placement to allow the mesh holes to gape slightly. The borders of the graft were allowed to overlap the border of the recipient site by 1cm. The entire limb was then immobilized with a non-adherent, absorbent, modified Robert-Jones bandage by using, in order, non-adherent chlorhexidine acetate gauze, 10 layers of sterile surgical gauze followed by roll cotton, roller gauze, crepe bandage and a self-adherent stretch wrap.

Strict immobilization of skin grafts for the first week is necessary to encourage graft take. This was achieved by using a combination of oral diazepam (Diapo 5; Upha) at 2.5mg/kg three times a day as a sedative for the first 5 days after surgery, and by leaving on the modified Robert-Jones bandage applied after surgery. Due to the presence of *Pseudomonas aeruginosa*, cultured from the open wound on day 17 of hospitalisation, antibiotic therapy was changed on the day of surgery from clavulanic acid-amoxycillin to enrofloxacin at 5mg/kg daily for 21 days, and oral metronidazole (Medazole 200; Upha) at 10mg/kg twice daily for the first 5 days after surgery.

The bandage was first changed on days 5, 12 and 16 post-surgery. On day 5 post-surgery, the graft over the elbow joint was loose and wrinkled, and easily slid over the joint. The rest of the graft, however, appeared fixed to the recipient bed with only 50% of the graft appeared healthy. On day 12, 80% of the graft appeared healthy and well adhered to the recipient site, thus the sutures were removed. The loose graft over the elbow sloughed-off during bandage removal on day 16. No more bandage was used from day 16.

On day 17, the right forepaw was swollen proximal to the carpus, most likely due to the contraction of a band of skin, not graft, distal to the graft border. A daily compression bandage applied to that paw was only of transient benefit. No more attempts were made to treat this swelling as it was not harmful to the cat and the swelling was expected to spontaneously resolve

once vascular channels between graft and normal skin normalised.

On day 37, a thoracodorsal axial flap was carried out in an attempt to cover the elbow wound. However, it failed due to constant elbow movement and the defect, measuring about 4cm in diameter, was subsequently treated as an open wound. The cat was discharged 85 days after presentation to the UVH, 63 days post-surgery with grafted skin well healed, mildly swollen right fore paw and a 2cm diameter healing right elbow wound.

Case 2 – Split-thickness mesh graft

A male 2-year-old Golden Retriever weighing 28kg was referred to the UVH-UPM with a history of being hit by an automobile 7 days previously. The dog had been stabilised medically prior to referral for a skin graft. A deep de-gloving injury of the left pelvic limb, extending from the tarsus to the metatarsus, approximately 12cm x 8 cm. The tarsus was found unstable through radiography and palpation, due to the loss of the medial malleolus and its collateral ligaments.

The necrotic tissue on the left pelvic limb was debrided under halothane general anaesthesia and an absorbent non-adherent dressing was applied with splint to immobilise the hock. The dog required meperidine hydrocholoride analgesia for the first 2 days. Wound management from then on consisted of wound cleaning twice daily by flushing with normal saline and povidone iodine solution (Povidin; Xepa Soul) diluted 1:10 with water. This was followed by application of absorbent non-adherent dressings as described earlier in Case 1. As the bandages became quickly soaked with discharges, bandaging required changing twice daily. Cephalexin (Ceporex; Glaxo) was given orally at 20mg/kg twice a day for 7 days.

A full-thickness mesh skin graft was intended on day 15 post-trauma. As a large area of skin was required for the graft, the donor skin was harvested from both flanks. The procedure for the graft was similar to the procedure used in Case 1. However, the graft preparation required 4 hours due to the extensive amount of donor skin involved. Mayo scissors instead of Metzenbaums were used since the canine skin was thicker and heavier as well as greasy compared to the feline skin. It was necessary to use multiple simple interrupted sutures 2-3cm apart to tack the graft down to the recipient bed because the graft was excessively mobile over the grafted bed during attachment. This was different from the cat surgery where the graft did not slide once the periphery had been tacked down.

Prior to attaching the graft, a 1cm band of the new epithelialisation bordering the recipient site was removed to the level of the hypodermis. A non-adherent chlorhexidine acetate gauze, modified Robert-Jones bandage similar to the bandage used post-operatively on the cat but now combined with a resin cast (Dynacast Extra; Smith & Nephew) were applied externally to immobilize both the graft and the hock joint. Enrofloxacin at 5mg/kg was given once daily for 28 days to control graft infection. The bandages were changed on days 5, 12 and 20 post-surgery.

On day 5 post-surgery, the graft appeared pale but fully attached to the recipient site. It was still moist on days 12 and 20 post-surgery. The moistened areas appeared to be exuberant granulation tissue, pushing through the mesh holes. Light bandaging was carried out twice daily until day 58. On days 28, 32, 36 and 42 the hyper-granulating tissue was gently scraped off with the blunt edge of a scalpel blade. By day 42, there were still some remaining patches of the hyper-granulation of approximately 2cm x 3cm. Betamethasone-neomycin sulfate cream (Beavate-N; Upha) was applied daily onto the areas from day 42 to suppress granulation. By day 58, the hyper-granulation on the graft had regressed and the de-gloving injury was completely covered by a smooth, dry and patchily scaly skin, which had little hair growth at the caudal metatarsus. The graft was easily traumatised and the outcome was that of a split-thickness graft rather than a full-thickness graft.

DISCUSSION

The decision to carry out a skin graft depends heavily on economic considerations. Overall cost of a skin graft is very high, as prolonged hospitalisation is required for immobilisation as well as for control of infection. Multiple surgeries may be required to correct a defect. Infection of the graft is detrimental to its survival since it causes dissolution of fibrin attachments and production of exudate to lift the graft off the bed. *Beta*-haemolytic Streptococci and *Pseudomonas aeruginosa* are the two important and often isolated bacteria in skin grafts (Pope, 1988b). The use of enrofloxacin in both cases was able to control the bacterial infection. However, when grafts are discharging excessively, culture and sensitivity are recommended to decide on the most suitable antibiotic to be use.

Immobilisation of the recipient site is essential after surgery as any movement between the graft and bed has been shown to disrupt the healing processes (Pope, 1988b). Haematoma and seroma formed between the graft and recipient bed are the most common cause of graft failure but they can be prevented by the use of mesh grafts, as was carried out in this study, which allow the drainage of serum and exudate from the

recipient bed. Pressure bandages prevent seroma formation and contribute to immobilisation (Pope, 1988b). In Case 1, the combination of heavy bandaging and sedative for immobilisation was probably excessive. The same degree of graft protection would most likely have been achieved by placing more tacking sutures with a light absorbent bandage alone. The cat would be more comfortable and able to use the affected limb sufficiently to encourage better circulation. The tacking sutures would have ensured better and prolonged restriction of graft movement, rather than the bandage, which could cause graft movement during each bandage change. In Case 2, heavy bandages covered with a cast adequately reduced tarsal movement, which was the main consideration in this dog. Graft movement was primarily prevented with the numerous tacking sutures.

Physiological considerations in skin grafting include the state of the recipient bed and the type of graft to be used. Although healthy granulation tissue on the recipient bed is excellent for grafting, it is not essential (Pavletic, 1993). Full-thickness grafts are preferred on cats as the feline skin is thinner than that of the dog and the chance of an early and successful take is better (Swaim, 1986). The thin cat skin also makes a split-thickness graft technically difficult and offers little advantage over a feline full-thickness graft (Pavletic, 1994). Full-thickness grafts are also preferable for dogs as it provides good hair growth with durable skin. Split-thickness grafts, although more readily accepted at the recipient site, have the disadvantage that they will always be fragile, bleed and tear easily and are often devoid of normal hair growth (Probst *et al.*, 1983; Swaim, 1990). In Case 1, the full-thickness graft was taken well although a defect remained at the elbow due to the tearing away of the periphery sutures. Subsequently there was excessive graft movement and poor contact with the granulation bed causing graft necrosis. Although a thoracoaxial flap was attempted 37 days after the mesh graft surgery, it failed due to excessive movement at the elbow. The remaining defect became smaller by 50% with granulation over the following 26 days. In retrospect, pinch grafts may have reduced the wound closure time considerably and would have been more suitable in the elbow where constant movement contributes to the sliding of sheets of skin.

Hair growth is normally visible within 2-3 weeks post-surgery (Pope, 1988a). Generally, full-thickness grafts provide satisfactory if not complete hair re-growth as hair follicles are transplanted together with the graft while split-thickness grafts tend to heal with sparse to absent hair re-growth, depending on the thickness of dermis that is transplanted with the graft. However, one study showed that the hair re-growth even in full-thickness grafts can vary from none to normal (Pope, 1988a). This may be due to mechanical or physiological damage to the hair follicles during graft preparation or circulatory changes during the re-vascularisation period (Pope and Swaim, 1986). In Case 1, hair re-growth was obvious from day 12 whereas in Case 2, no hair grew even up to day 70. The failure of hair to re-grow in Case 2 was probably due to excessive removal of subcutaneous tissue by using heavy Mayo scissors rather than the lighter Metzenbaum scissors resulted in unintentional creation of an intermediate split-thickness graft and mechanical damage to the hair follicles. This would explain the final dry and friable appearance of the graft since split-thickness grafts tend to have sparse hair growth and a scaly appearance due to lack of sebaceous secretion resulting from loss of hair follicles (Probst *et al.*, 1983; Swaim, 1990). The second graft took twice as long as the first graft to prepare and this could also have contributed to irreversible and fatal changes in the hair follicles of the graft.

Immediately after surgery, grafts are expected to be pale due to expulsion of haemic elements, then cyanotic in the next 48 hours with a change to red 5-6 days later. Normal skin colour can be seen by day 14. Persistent graft paleness will indicate lack of vascularisation while black discolouration indicates dry ischaemic necrosis (Pope, 1988b). However, it is important not to remove grafts of questionable viability prematurely (before day 14), as they can improve as shown by the improved viability from 50% to 80% in Case 1 between days 5 and 12. Similarly in Case 2, although the graft was pale on day 5, by day 12, it become pink.

Case 1 had an interesting complication of a swollen paw distal to the de-gloving injury. The swelling was present the day after injury, reduced when the skin was incised the same day to allow lymphatic drainage, reappeared when pressure bandaging of the limb was stopped 39 days after injury and resolved spontaneously but slowly 85 days after the injury. Probst (1990) illustrated the mechanics of this problem with a similar case where swelling resulted from impaired venous drainage through scar tissue encircling the de-gloving injury; this contracting band could be described as a 'biological tourniquet'. Since Case 1 was grafted 3 weeks after the injury, the wound edges had ample time to form scar tissue. As this scar tissue or 'biological tourniquet' was not debrided at the time of grafting, it took longer than usual for the vascular channels to normalise. Learning from this experience, the surgeon removed the band of healing tissue in Case 2 that formed at the periphery of the recipient bed and avoided the potential complication.

In conclusion, four main points are noted. First, tacking sutures should be placed both at the graft-recipient bed junction and over the joints where

movement of the graft is expected to occur. Secondly, removal of subcutaneous tissue from a skin graft should be carried out carefully and swiftly to prevent partial or total loss of hair follicles. Thirdly, debridement of questionable tissue after grafting should be done conservatively because the graft viability will likely improve considerably within the first 2 weeks. Finally, removal of the scar tissue at the periphery of the de-gloving site will improve circulation to and from tissues distal to the graft.

REEFERENCES

Pavletic, M.M. (1993). *In:* Atlas of Small Animal Reconstructive Surgery. J.B. Lippincott Co., Philadelphia. pp122-123, 242-243.

Pavletic, M.M. (1994). Surgery of the skin and management of wounds. *In*: The Cat: Diseases and Clinical Management Vol 2, R.G. Sherding (Ed.). W.B. Saunders Co. p1993.

Pope, E.R. (1988a). Skin grafting in small animal surgery part 1. The normal healing process. *Comp. Continuing Edu. Prac. Vet.* **10**: 7-12.

Pope, E.R. (1988b). Skin grafting in small animal surgery part 2. Full-thickness skin-grafting techniques. *Comp. Continuing Edu. Prac. Vet.* **10**: 1068-1074.

Pope, E.R. and Swaim, S.F. (1986). Wound drainage from under full-thickness skin grafts in dogs. Part 2. Effects on cosmetic appearance. *Vet. Surg.* **15**: 72-78.

Probst, C.W. (1990). Grafting techniques and failures in small animal surgery. *Prob. Vet. Med.* **2**: 413-423.

Probst, C.W., Peyton, L.C., Bingham, R.G. and Fox, N.M. (1983). Split thickness skin grafting in the dog. *J. Am. Anim. Hosp. Assoc.* **19**: 555-568.

Swaim, S.F. (1986). The full-thickness mesh graft. *Vet. Med.* **81**: 1-6.

Swaim, S.F. (1990). Skin graft. *Vet. Clin. North Am. Sm. Anim. Prac.* **20**: 147-174.

RINGKASAN

CANTUMAN KULIT JEJARING UNTUK MENGURUS LUKA KAKI: LAPORAN DUA KES

Seekor kucing dan seekor anjing telah dirujuk ke Hospital Veterinar Universiti, Universiti Putra Malaysia dengan kecederaan nyahsarung masing-masing pada kaki depan kanan dan kaki belakang kiri. Kecederaan ini telah dirawat dengan cantuman kulit jejaring sepenuh-tebal. Hasil daripada pencantuman pada kucing adalah baik dengan 80% cantuman 'diterima' dan pertumbuhan rambut yang memuaskan. Bagaimanapun, pada anjing, cantuman jejaring sepenuh-tebal yang dirancang itu telah menjadi cantuman jejaring belah-tebal disebabkan penyahlemakan lampau berlaku dalam persediaan cantuman. Dalam kes ini, 100% cantuman 'diterima' tetapi rupanya tidak memuaskan sebab pertumbuhan semula rambut sedikit, sambil kulit tercantum pula masih nipis dan mudah tercedera.