PAD REPAIR AND RECONSTRUCTION

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Key Points

- Loss or injury of pad tissue, despite an otherwise normal limb, can result in complete loss of limb function, so preserving pad function is critical for most small animals.
- Skin around the pad may in some cases be able to adapt to function similar to pad tissue but it is generally accepted that adjacent skin is not a suitable replacement for lost pad tissue, particularly in active larger dogs.
- Most superficial pad lacerations heal without complications regardless whether they are repaired or not, if bandaged appropriately. Full thickness pad lacerations should be repaired with a two-layer technique and bandaged to relieve motion and pressure on the repair.
- Pad loss can be managed successfully using a variety of techniques from digital pad transfer, pad repositioning, microvascular pad transposition, or pad grafting.

Paw pads of dogs and cats are durable specialized skin structures that provide cushioning, abrasion resistance, and traction. Loss or injury of pad tissue, despite an otherwise normal limb, can result in complete loss of limb function, so preserving pad function may be critical to the well-being of a small animal patient. This session provides a review of the considerations and options for paw repair and reconstruction, as well as a summary of a recent retrospective study examining pad injury conducted by the author.

When compared to adjacent skin, pads contain an increased amount of keratinized epidermis (stratum corneum) suitable to resist weight bearing forces. A fibrous dermal layer (often considered the strength holding layer) contributes strength to resist the sheer forces generated during weight-bearing and motion. The deeper fibroadipose layer acts as a dermal cushion. Skin around the pad may in some cases be able to adapt to function similar to pad tissue but it is generally accepted that adjacent skin is not a suitable replacement for lost pad tissue, particularly in active larger dogs. Therefore, pads should be properly preserved and repaired in surgery, if possible.

Pad Repair- Lacerations

Superficial and full thickness injuries to pads generally heal in a similar fashion when compared to other skin surfaces. Anecdotally, it has been stated that pad injuries heal more slowly and with more complications, however, when compared to similar injuries to skin. Pads are exposed to contaminated surfaces, excess motion and tension, and self-trauma. In addition, paws are difficult to aseptically prepare, so contamination of paw wounds may be common. One experimental study showed that full-thickness metatarsal pad lacerations healed well with suture repair or when left open for second intention healing as long as they were bandaged. Wound strength at 16 days was not different between groups. No other studies have examined pad injuries or repair techniques in the veterinary literature. In a recent retrospective study of 121 pad injuries conducted at Colorado State University, the following key points were found. Dogs were much more likely to have a front limb injury and statistically more likely to have a full thickness injury when a front limb injury occurred. Full thickness lacerations were 10 times

more likely to be repaired and 2.5 times more likely to be bandaged than partial thickness lacerations. There were very few concomitant injuries to other paw structures, and only one dog experienced a tendon laceration. Full thickness lacerations developed more complications than superficial wounds, but the majority of wounds regardless of thickness were healed within 17 days. Wounds that developed major complications such as infection or dehiscence healed within a mean 32 days. Superficial wounds whether they were repaired or not healed within 2 weeks without major complication. All pads were healed and the dogs were sound by six months. My recommendation based on this study and my personal experience is that superficial thickness wounds do not need to be repaired but should be protected for two weeks. Full thickness pad lacerations (if the underlying tissue condition is acceptable) should be primarily repaired with preplaced interrupted (buried knot) deep 4-0 monofilament suture (polydioxane or polyglyconate) incorporating the dermis as the primary strength layer, with wide and deep mattress bites through the pad tissue (2-0 monofilament nonabsorbable suture material). Proper bandaging that incorporate a donut foam pad over metacarpal/tarsal pad lacerations are recommended.

Pad Reconstruction

The amount of pad tissue needed for acceptable limb function is unknown, but is likely dependent upon the weight and lifestyle of the patient. The forelimb possesses digital pads, a metacarpal pad, and a small non-weight bearing carpal pad, while the hindlimb possesses digital pads and a metatarsal pad. A recent study involving greyhounds and Labrador retrievers on a pressure-sensitive walkway supported the long-held belief that the 3rd and 4th digital pads, along with the metacarpal and metatarsal pads, are the major load bearers. It also believed that preservation of the metacarpal and metatarsal pads greatly increases the likelihood of maintaining limb function. It has been reported that cats can bear weight adequately on a non-padded, full-thickness skin surface when confined to a carpeted house. However, in general, any viable pad tissue should be conserved when paw salvage is to be attempted in either dog or cat.

The decision to salvage a paw through reconstructive techniques must include evaluation of the entire patient and an understanding of abnormal forces which may result in flap or graft failure. Large patients, particularly those burdened with orthopedic or neurological diseases in other limbs, should be strongly considered for paw salvage because limb amputation may result in poor overall ability to ambulate. Loss of pad tissue typically results from trauma (e.g. vehicular, bandage ischemia, frost bite, leg trap) or tumor excision. However, abnormal limb carriage due to neurological or orthopedic disease can also result in paw injury by increasing loads and shear forces on the tissues. Attempts to treat such wounds without addressing the underlying cause of gait abnormality are prone to failure.

A variety of techniques for paw salvage have been experimentally and clinically tested which involve the transfer of durable pad tissue into areas of pad loss or weight bearing. Pad tissue can be obtained either remotely (via segmental pad grafts or microneurovascular anastomosis of a distant pad) or locally (via a flap of an adjacent pad). Pad tissue is typically obtained locally whenever possible due to the decreased technical demand and increased likelihood of flap survival.

When pad tissue is unavailable adjacent to a weight-bearing defect, techniques such as segmental pad grafting or microneurovascular pad anastomosis should be considered to obtain it from afar. Experiments have shown that segmental pad grafts should be rectangular and placed circumferentially around the wound edge. This blocks the rapid centripetal growth of thin,

delicate epithelium from surrounding skin while allowing tough, keratinized epithelium from the pad grafts to grow and coalesce over the weight-bearing surface. Used in this fashion, segmental pad grafting was also shown to be effective in one trauma case report. A creative use of segmental pad grafting was illustrated in another report in which traumatically severed pads were first grafted to the cutaneous trunci muscle and then transferred back to the paw via a direct flap technique.

Another option for challenging paw salvage situations is microneurovascular pad anastomosis. This technique is technically difficult and requires microsurgical instrumentation. Flaps including the 5th digital pad of the hindlimb and the carpal pad have been successfully anastomosed into metacarpal defects.

Depending on the joint level of injury, any of the paw pads (carpal, metacarpal, metatarsal, or digital) can be transferred as local flaps to provide a suitable weight-bearing surface. Single pedicle and bipedicle advancement flaps incorporating the carpal pad were described in the treatment of a small dog and a catwhich had suffered carpo-metacarpal amputations (Figure 1). Metacarpal pad advancement was successfully used to salvage a dog's limb after all digits were amputated at the metacarpo-phalangeal level (Figure 2).

Fig. 1

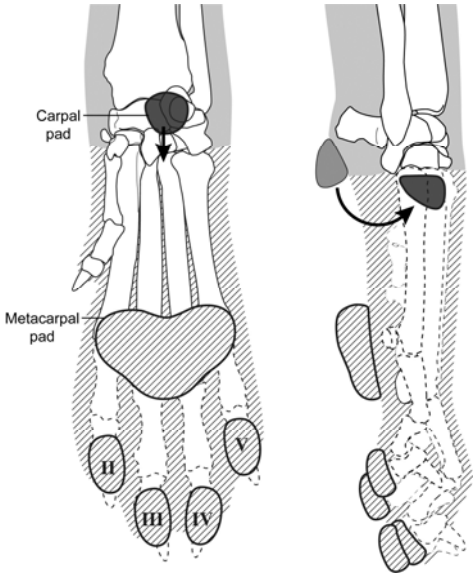
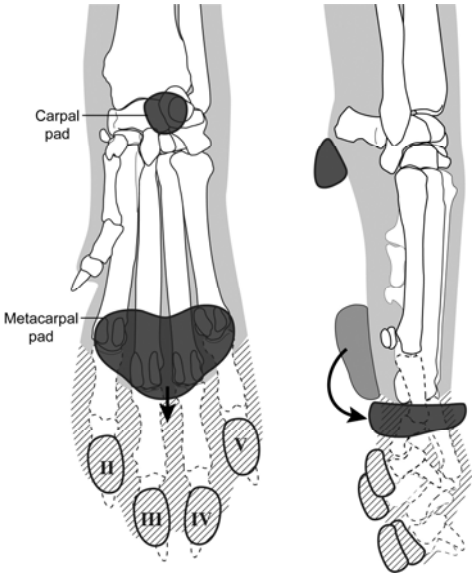


Fig. 2



Transposition of one or more digital pads is typically employed to replace metacarpal or metatarsal pad loss (Figures 3 and 4). Its use has been reported in the paw reconstruction of one canine with severe forelimb trauma, one feline with a tumor in a non-weight bearing area of the paw, and four canines with metacarpal or metatarsal pad neoplasia (three melanomas and one fibrosarcoma). Surgery-related outcome for the majority of these patients was generally good, with the exception of the fibrosarcoma patient who underwent limb amputation due to incomplete tumor excision.

Fig. 3

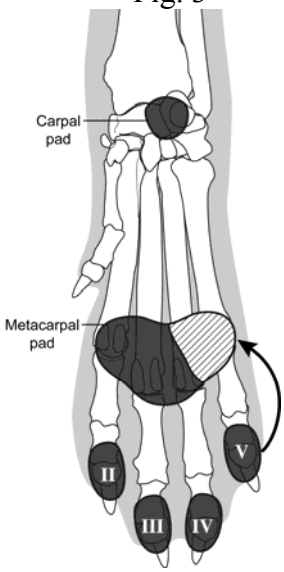


Fig. 4

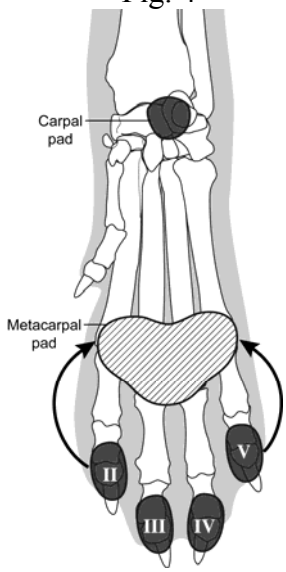


Fig. 5: Metatarpal pad defect (85%) repaired by the second and fifth digital pads.

Based on this review of ten consecutive digital pad transposition cases, it can be expected that the majority of patients that undergo the technique enjoy complete healing within one to two months and regain limb function in the same time period, although patients with extensive pre-existent trauma may not fair as well as those with localized disease such as a tumor. Early complications typically are minor and resolve without further surgical treatment. When designing the reconstruction of a paw, digital pad transposition should be considered first for any defect affecting the metacarpal or metatarsal region that would benefit from additional pad tissue. Generally, defects in the metacarpal or metatarsal pad of less than 1/3 the surface area can heal successfully without the need for reconstruction.

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