Pelvic limb removal by coxofemoral disarticulation in 13 dogs

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ABSTRACT

Hindlimb amputation may be necessary in cases of neoplasia, neurogenic atrophy, permanent functional impairment from chronic orthopaedic disease and severe soft tissue injury. Midshaft femoral amputation may not be satisfactory when wide tissue margins are required. This report describes the procedure and the results of two techniques of hindlimb removal. The first disarticulation technique leaves the thigh musculature attached to the body and the second technique is an 'en bloc' resection of the rear leg. Five clinical cases leaving the thigh musculature intact and eight clinical cases of en bloc resection are summarised. Indications and complications are discussed. Although not curative in all cases, all owners were satisfied with the end surgical results and functional outcome.

INTRODUCTION

Hindlimb removal is less frequently performed in present day veterinary medicine than previously due to advancements in management of fractures and soft tissue injury. Hindlimb amputation has been performed at the level of the proximal third of the femur by either muscle belly transection (Slocum 1975, Peddie 1980, Stone 1985, Weigel 1985) or by elevation of the musculature from the femur (Knapp 1990). Amputation by disarticulation of the coxofemoral joint may be achieved by muscle belly transection (Weigel 1985), by muscle elevation (Knapp 1990), or by the removal of all the thigh musculature (Knapp 1990). The choice of technique is determined by the location of the soft tissue or bony lesion and the biological behaviour of the disease process. The most common technique used is the proximal midshaft femoral ostectomy. However, certain cases require a more radical approach and a disarticulation technique should be chosen. Indications for hindlimb removal by disarticulation include chronic non-responsive osteomyelitis, extensive soft tissue damage, neoplastic disease, arteriovenous fistulae, congenital limb deformity, and occasionally for highly comminuted proximal femoral fractures which cannot be reduced and stabilised. The purpose of this report is to describe two techniques for hindlimb disarticulation and illustrate their use with 13 case summaries of dogs managed by these procedures.

MATERIALS AND METHODS

Thirteen dogs presented to the University of Missouri-Columbia Veterinary Teaching Hospital (UMCVTH) were subjected to amputation using one of two techniques of disarticulation. Pelvic limb abnormalities were diagnosed using history, physical examination, culture and sensitivity, biopsy, and radiographs as indicated. Dogs 1 to 5 were treated with thigh muscles left attached to the body. Two of these were treated for severely comminuted proximal femoral fractures and three were treated for osteomyelitis and non-union fractures.

Dogs 6 to 13 had disarticulations that involved removal of the thigh musculature. Seven dogs were treated for neoplasia and one for a severely comminuted proximal femoral fracture with extensive soft tissue damage. Routine anaesthetic regimes were employed and postoperative analgesics were administered when indicated. Hospitalisation varied from two to 12 days. After
release from hospital, each patient was monitored by telephone contact with the owner on a regular basis. Necropsies were carried out when possible.

**Surgical procedure**

With either procedure, the patient was placed in lateral recumbency with the affected limb uppermost. A wide clip was performed beginning at the hock and extending over both dorsal and ventral midlines and 5 to 7 cm cranial to the wing of the ilium. The leg was suspended and a surgical scrub performed. After routine draping an initial skin incision was made sufficiently distal to assure ease of closure; if excess skin remained at the time of closure, it was trimmed to permit a more cosmetic appearance of the wound.

**Coxofemoral disarticulation with thigh musculature left intact**

The lateral skin incision started at the fold of the flank and curved caudal and distal to the level of the proximal stifle and continued back proximally and caudally to the ischiatic tuberosity. The medial skin incision followed the same curve as the lateral incision only to the level of the midfemur, and connected the two ends of the lateral incision. It was necessary to undermine the lateral skin flap proximal to the level of the greater trochanter to expose the insertions of the gluteal muscles. Undermining the distal lateral skin margin exposed the biceps femoris muscle which was transected at its insertion on the fascias lata and cruris and reflected proximally to expose the deeper structures. The tendon of the quadriceps femoris muscle was isolated just proximal to the patella and transected. The semimembranosus and semitendinosus muscles were isolated and transected at their insertions on the fascia of the stifle and the tibial crest, respectively (Fig 1).

The limb was abducted to gain access to the medial structures. The major vessels were double ligated, transfixed, and divided. These were branches of the femoral artery and vein, the saphenous vessels and the descending geniculate vessels. Next, the insertions of the two bellies of the sartorius muscle and the gracilis muscle were located and transected at their insertions on the medial fascia of the stifle and tibia and reflected proximally. The distal femoral diaphysis was then completely exposed. The caudal aspect of the femoral shaft was exposed to the level of the greater trochanter by subperiosteally elevating the adductor magnus et brevis and pectineus muscles from their insertions. The lateral, cranial, and medial surfaces of the femoral shaft were exposed by elevating the vastus lateralis, vastus intermedius, and vastus medialis muscles from their origins on the proximal femur (Fig 2).

The leg was returned to an adducted position. The skin was reflected to expose the greater trochanter and the superficial gluteal muscle was tenotomised at its insertion on the femur. A combined tenotomy of the middle and deep gluteal muscles was carried out at the level of the greater trochanter, the muscles elevated from the coxofemoral joint capsule, and reflected craniodorsally (Fig 3). The sciatic nerve was transected at its proximal extent. The tendons of the external rotator muscles of the hip were isolated at their insertions in the trochanteric fossa and the
internal obturator, external obturator, gemelli, and quadratus femoris muscles were tenotomised at their insertions. The limb was again abducted to allow the adductor longus and iliopsoas muscles to be elevated from their insertions on the femur (Fig 4). The limb was now attached to the body only by the joint capsule and the round ligament. Both were incised to free the leg. Due to the close adherence of the articularis coxae muscle to the joint capsule, it was transected at the time of the incision of the capsule.

To close the wound, cranial muscle groups were sutured to caudal muscle groups and medial musculature to lateral muscles. The tendons of the gluteal muscles were sutured to the cranial edge of the biceps femoris. The tendons of the adductor magnus et brevis, semimembranosus, and semitendinosus muscles were brought cranially and sutured to the patellar tendon of the quadriceps femoris muscle. The distal portion of the biceps femoris muscle was carried medially and sutured to the sartorius and gracilis muscles using an interrupted horizontal or continuous mattress pattern. The end result was a compact muscle mass, with very little dead space, similar to the contour of the initial skin incision. Subcutaneous and skin closures were routine. Because the lateral skin flap was longer, the suture line was located medially, thereby serving two functions; first to hide the scar and second, since the lateral skin is thicker than the medial skin, it served better to protect the stump from trauma.

The use of drains was left to the discretion of the surgeon. If haemostasis was adequate, drainage was not necessary.

Disarticulation with removal of the thigh muscles

The lateral skin incision began at the flank and continued caudodistally, curving to the proximal midthigh and back up to the point of the ischiatic tuberosity. The medical skin incision connected the ends of the lateral incision, following the same curve as the lateral, only not as far distally. The lateral skin was undermined proximally to expose the greater trochanter. Undermining of the skin on the medial aspect extended to the level of the ventral midline.

Bleeding was controlled by ligation of the femoral artery and vein early in the procedure. The femoral vessels were easily isolated on the medial aspect of the proximal thigh as they left the abdomen. In cases where neoplastic or septic emboli were of concern, the vein was double ligated, transfixed, and divided first. The femoral artery was isolated, double ligated, transfixed, and divided at a point proximal to the superficial circumflex iliac artery and lateral circumflex iliac artery.

Grouping the muscles according to anatomic location rather than approaching each individually made disarticulation easier, and detaching the muscles at either their origins or insertions decreased haemorrhage. With the leg still abducted, the muscles of the caudal medial thigh were elevated. The pectineus muscle was incised at...
The cranial thigh muscles were elevated from their origins on the body and wing of the ilium. The thin triangular tensor fascia lata muscle was dissected from its combined origin on the tuber coxae and aponeurosis with the gluteal muscles and reflected distally. The cranial and caudal bellies of the sartorius muscle were freed by periosteal elevation from the iliac crest and lumbodorsal fascia and reflected distally. The rectus femoris muscles was elevated subperiosteally from its origin on the iliopubic eminence. The iliopsoas muscle was elevated free at its attachment on the lesser trochater of the femur. At this point, the rear leg was held in place by the coxofemoral joint capsule and round ligament (Fig 8). Dissection of these structures completed the rear limb disarticulation.

To close the wound, the remaining muscles were opposed using absorbable suture material in an interrupted horizontal mattress pattern. The glutteal muscles were sutured to the external rotator muscles and the iliopsoas muscle was pulled caudally and sutured to the external obturator muscle. The closure of these muscles resulted in a muscular layer covering the acetabulum; which, although not absolutely necessary, allows for a more cosmetic effect following the fibrosis and atrophy that ensues. It also helps to prevent pressure sores.

The extensive undermining of skin and the large amount of muscle removed created a large dead space. Closed suction drainage was used and care was taken to avoid ascending infection. To avoid perianal contamination, drains emerged

The leg was adducted to approach the caudolateral thigh muscles. The biceps femoris muscle was dissected free from its combined origin on the sacrotuberous ligament and lateral aspect of the tuber ischiadicum. Care was taken not to damage the integrity of the sacrotuberous ligament which serves as a major component of the support for the pelvic diaphragm. After reflecting the biceps femoris muscle distally, the sciatic nerve was readily visible and was transected proximally as it passed over the greater ischiatic notch.

The muscles covering the lateral aspect of the femoral head and neck were removed next. A tenotomy of the superficial gluteal muscle at the level of the third trochanter followed by craniodorsal retraction exposed the deeper gluteal muscles (Fig 6). The middle and deep gluteal muscles were tenotomised at their insertions on the greater trochanter and reflected cranial and dorsal (Fig 7). The tendons of insertion of the external obturator, internal obturator, gemilli, and quadratus femoris muscles were incised at their attachments in the trochanteric fossa.
Pelvic limb removal by disarticulation

FIG 7. Lateral aspect of the proximal thigh. The tendons of the middle and deep gluteal muscles are transected. The origin of the rectus femoris muscle is isolated and elevated from the body of the ilium. The cranial and caudal bellies of the sartorius muscle are isolated and elevated from their origin on the wing of the ilium. (Reprinted with the kind permission of Lea and Febiger)

at the cranial aspect of the wound. Postoperatively the surgical incision and drain exit areas were covered with a sterile dressing which was maintained for several days post-drain removal. If the wound was closed without drains, a pressure bandage helped to reduce dead space and subsequent seroma formation.

The use of prophylactic antibiotics was left to the discretion of the surgeon. When disarticulation was used as a treatment for osteomyelitis or soft tissue infection, an intraoperative culture and sensitivity was performed and appropriate antibiotic therapy instituted.

RESULTS

No complications were observed in the five dogs who underwent disarticulation with the thigh muscles left intact. All were ambulatory at release from the clinic, which ranged from two to five days postoperatively. Telephone contact indicated four dogs had returned to a functional level of activity (how long after surgery?) with no problems or adverse affects due to the disarticulation. One dog was lost to follow up, but was seen by the referring veterinarian two months post disarticulation, who indicated the dog had recovered without any problems.

Five of the dogs whose disarticulation involved removal of the thigh musculature died or were euthanased as a result of the primary disease process. Dogs 6, 8, and 9 had osteosarcoma and were euthanased because of lung metastasis. Dogs 6 and 8 (both primary bone tumours) had complete necropsies performed and no tumour recurrence at the surgical site was found. Dogs 9 and 10 (a primary bone tumour and a mast cell tumour) underwent necropsy by the referring veterinarians; no recurrence at the surgical site was noted in either case. Dog 7 died two days after the disarticulation. Necropsy indicated necrotising and phlegmonous myositis of the remaining musculature of the left pelvic girdle, the left inguinal area and the abdominal wall musculature. Clostridial organisms were found on culture. Dog 10 was found dead by the owner but no definitive diagnosis was made. Dog 11 has survived three months and dogs 12 and 13 have survived four months at the time of writing.

DISCUSSION

Hindlimb amputation involving muscle transection has been well described (Slocum 1975, Peddie 1980, Stone 1985, Weigel 1985). Because the belly of the muscle is incised, haemorrhage is more profuse than when muscles are detached at their origins or insertions. The advantage of decreased haemorrhage by elevating and rolling the thigh musculature proximal to the stifle may be applied to midshaft femoral amputation as well as the disarticulation technique.

The need to remove the entire femur yet leave the thigh musculature intact occurs less frequently than midshaft femoral amputation. Indications
include osteomyelitis of the femur or, on rare occasions, highly comminuted fractures of the proximal femur. The technique takes longer than midshaft femoral ostectomy, in that more exposure is necessary to visualize the area of the femoral head and neck, but the outward appearance of the stump is similar.

Disarticulation with the thigh musculature left intact is the preferred method as the results are more cosmetic. In the male dog, the stump serves to cover the scrotum and prepuce and protect the external genitalia. The procedure is easier and postoperative management is much less, thereby minimizing the hospitalization period. Previous studies have described owner satisfaction with results of amputation (Withrow and Hirsh 1979, Carberry and Harvey 1987). In this study all owners were apprehensive initially, but when contacted subsequently, they were very satisfied with the results. Dogs that are non-weight bearing for a period of time before amputation tend to adjust quicker to the three-legged state, with less exercise intolerance, than the dogs which have disarticulation owing to an acute disease process.

Disarticulation with removal of the thigh muscles is advocated in cases when an ‘en bloc’ resection is necessary. With a better understanding of neoplastic processes and their biological behaviour, amputation has become an integral component of cancer therapy. Because disease processes requiring wide margins generally have a poorer prognosis, this procedure is often not curative. The most common neoplastic disease requiring limb disarticulation is a primary malignant bone tumour. Large and giant breed dogs are most commonly affected and anatomically the distal femur and proximal tibia are the most frequently affected sites of the hindlimb. Until curative techniques or limb sparing procedures (Vasseur 1987, LaRue and others 1986) are readily available and economically feasible, limb removal will remain the palliative treatment of choice for malignant bone tumours. Because dogs may experience a great deal of pain due to periosteal expansion and pathological fractures with bone tumours, the aim of amputation is pain relief. This permits the animal a higher quality of life for the remainder of its life.

Tumours of soft tissue origin may also require disarticulation. Haemangioepireticytoma, due to its invasive nature and frequent recurrence after surgical removal, may require limb removal to obtain adequate margins. Synovial cell sarcoma is often treated by amputation. Mast cell tumours as well as any other tumour, which, when totally resected, cause impairment of normal limb function which may then require disarticulation. The aim of removing all the muscles associated with the femur is to prevent local recurrence. No post-mortem evidence of recurrence at the surgical site was seen in the four cases of neoplasia treated by disarticulation. There have been no reports on the frequency of tumour recurrence at the surgery site following femoral ostectomy. Metastatic disease has been the main postoperative concern as was evidenced in this study by dogs 6, 8, and 9.

The only major complication was soft tissue infection noted in two of the dogs that had the thigh musculature removed. The owners of dog 8 refused disarticulation until a clostridial infection, causing a life threatening septic crisis, forced limb removal. The residual soft tissue infection was successfully treated with drains and antibiotics. Dog 7 had the limb removed because of a fractured femur caused by gunshot. The dog had been missing four days and his condition was poor at presentation. In retrospect the authors feel that even with removal of the leg, the treatment was not as aggressive as needed. Necropsy results indicated a more extensive lesion than was suspected at the time of presentation. The delay from time of injury to time of surgery was most probably the major reason for failure.

**CONCLUSIONS**

It is felt that the two techniques of disarticulation serve a useful purpose in veterinary surgery and should be performed for disease processes which require a more radical approach than a femoral midshaft amputation. When used to treat a non-life threatening disease process (often as a salvage procedure for such diseases as non-responsive osteomyelitis or non-union fractures), the results were satisfactory. Malignant neoplastic processes treated by disarticulation were satisfactory with respect to pain relief and prevention of local recurrence but had no effect on the final outcome. Tumours of soft tissue origin which are slow to metastasise may be cured by disarticulation provided wide tissue margins are achieved. Further studies will be necessary to substantiate this statement.

**REFERENCES**


BOOK REVIEW

Small animal nutrition

Nutrition of the Dog and Cat.

This book is based upon papers presented at the 7th Waltham symposium on dog and cat nutrition held in Cambridge in 1985. It contains 24 chapters on essentially different subjects written by over 30 authors.

Although the original symposium was described as being on ‘Recent advances’ I think it is fair to say that most of the information in this text has already been published in other sources, indeed some of the authors describe their manuscripts as review articles. Nevertheless, the book contains a lot of information that the veterinary student, or veterinary surgeon in practice may not have been exposed to.

I particularly enjoyed some of the introductory chapters such as ‘Why cats and dogs’ by R. S. Anderson and ‘Optimal ranges of actual nutrients’ by D. S. Kronfield and C. A. Banta. The first was a historical overview of the two most popular pets and their position in human society. The latter, an interesting discussion on the actual needs of the animal in terms of the amounts of nutrients required to be in the diet. The limitations of our current knowledge on nutrient requirements were clearly pointed out, and the future need to determine bioavailability well emphasised.

Chapters dealing with basic nutrition included those on allometry, comparative dog and cat nutrition, bodyweight and energy intakes in cats, as well as chapters on protein in the nutrition of dogs and cats, carbohydrates in pregnancy and lactation, and essential fatty acids in cats.

Clinicians will find the chapters on lactose-induced diarrhoea, feline struvite urolithiasis, calcium metabolism and skeletal development in dogs, the effects of overfeeding growing great danes, and the role of zine in canine and feline nutrition particularly interesting and relevant. Dr A. R. Michell’s chapter on salt intake, animal health and hypertension poses some very interesting questions about the undesirability of excessive nutrient intake, even when the detrimental effects are not clearly defined.

Over recent years there has been a surge in public and veterinary interest in nutrition, particularly in regard to the relationships between diet and disease. Traditionally, avoiding deficiency disease was the main focus of attention in nutrition, but now avoidance of excesses as epitomised by the chapters in this book on calcium, lactose, salt and overfeeding is a major area for concern, research and development.

In the last chapter the editors have tried to address the future. It was disappointing to read their section on ‘Nutrition and disease’ in which they failed to quote a reference more recent than 1957! The editors claim that they could ‘bring no evidence (other than obesity or bone and joint disease)’ to support their view that ‘apart from simple deficiencies, nutrition may play a role in diseases of dogs and cats’. Either they didn’t look for the evidence, or they decided not to present it!

There have been numerous publications demonstrating the role of nutrition in disease; three of the chapters discuss the role of diet in disease. In the chapter entitled ‘Diet in feline struvite urolithiasis’ the author states that ‘The diet is of primary importance in the aetiology of FU’ but in the chapter on lactose-induced diarrhoea the authors begin ‘Large amounts of lactose clinically cause severe diarrhoea’.

Probably the only weakness in this book is the occasional tendency for authors to express opinions that either reflect their own personal viewpoint, or that fail to give due recognition to other views. Differentiating fact from opinion will be difficult for the uninformed reader, however, this should not detract from the value of this text and the positive information that it contains.

In any event polarisation of views is probably helpful in that it encourages commercial resources to be directed towards proving or disproving the contrary viewpoint. This is important as, notwithstanding the knowledge that we already have in the field of nutrition, there is still so much basic work to be done which hopefully will result in a precise definition of optimal nutrition for animals in health, and in disease.

The context of this book is so varied that I am sure all readers will find something of interest, and the editors have certainly succeeded in their stated aim to produce a book that ‘conveys the challenging nature and practical importance of this somewhat neglected area’. I hope you will go out and buy it!

M. Davies