Rehabilitation after extra-articular stabilisation of cranial cruciate ligament rupture in dogs

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Summary
Patients at the Blue Star Foundation animal hospital in Gothenburg, Sweden, underwent a procedure with an extra-articular suture technique for cranial cruciate ligament rupture. Two groups were compared; one of the groups received rehabilitation by the owner, and the other received professional rehabilitation by a trained physiotherapist. The dogs where reexamined at four, 12 and 24 weeks postoperatively. The results were 'good' in both groups but a difference was not seen between the groups. This study shows that in the dogs with a body weight of between 25 and 50 kg with cranial cruciate ligament rupture, the extra-articular suture technique gives good results, provided that the dogs are actively walked on the leash postoperatively.

Keywords
Cranial cruciate, rupture, rehabilitation, physiotherapy, dog

Introduction
Cranial cruciate ligament rupture is the most common orthopaedic complaint that affects dogs (1–3). According to the statistics of the animal insurance company AGRIA (350,000 insured dogs), between 2000–2002, 2.5 to 3% of claims received were for the treatment of cranial cruciate ligament rupture (2). The incidence of these claims varied from one breed to another; from 0.1% in Dachshund to over 10% in Chow Chow, large Swiss Sennen Hounds and American Bulldogs.

The reason why some dogs are affected more than others might lie in the difference in their constitution. In dogs that have straight knee angulations and/or that are overweight, the cranial cruciate ligament is exposed to more stress, which predisposes to degenerative changes in the cruciate ligament (1, 3–9). Whether a steep tibial slope contributes to cruciate ligament rupture remains controversial. Total ruptures often occur in relation to trauma, but the ligament usually has degenerative damage long before the cruciate ligament completely ruptures. In 20 to 40% of dogs with cruciate ligament rupture, the contralateral cranial cruciate ligament also ruptures later on (1, 3–7, 10–12).

Arthritis is often observed as a secondary complication of cranial cruciate ligament rupture (13–16, 18–20). The risk of medial meniscus injury increases as the amount of time elapses between the injury and stabilisation of the stifle (1, 4, 10–12, 15, 17, 19).

Treatment of cruciate ligament rupture is either conservative or surgical. In a study carried out in 1984, Vasseur showed that conservative treatment was most suitable for small dogs weighing less than 15 kg (21).

A surgical technique by Robson Mayo, designed to stabilise the stifle joint with cruciate ligament injury, was first published in 1903 (22). Since then, many different techniques have been described (8, 16, 18, 23–29). Surgical stabilising techniques may be classified as either intra-articular or extra-articular. Intra-articular techniques generally employ a variety of autografts, such as the patella ligament, hamstring muscles or fascia lata (6, 8, 11, 12, 23). The majority of human surgeons prefer intra-articular techniques and surgery often makes use of arthroscopy (29, 30). Extra-articular techniques can employ autografts but synthetic materials, such as monofilament nylon, polypropylene or steel wire, are common (16, 19, 24, 25, 28, 32).

Treatment for cranial cruciate rupture in dogs has radically changed during the last 15 years with new techniques arising, such as tibial plateau leveling osteotomy (TPLO), tibial tuberosity advancement, triple tibial osteotomy and tibial wedge osteotomy (27). All of these techniques eliminate cranial tibial thrust in the cranial cruciate ligament deficient stifle during weight bearing on the limb.

Over the last decade, the importance of physiotherapy and rehabilitation following cruciate ligament surgery has been recognised in both humans and dogs (20, 34–37). Likewise, new and better drugs for pain relief have improved the outcome of stifle operations (31, 38, 39). The use of ice packs has also enabled a reduction in postoperative swelling and pain (31, 37, 39).

The purpose of this study was to evaluate an extra-articular operative technique and to study rehabilitation carried out by the owner, or in conjunction with rehabilitation supervised by a physiotherapist.

Materials and method
The surgical operation was performed on 39 dogs with cranial cruciate ligament rupture.
One of the dogs underwent surgery on both stifles at an interval of 24 months. All dogs were patients of the Blue Star Foundation animal hospital in Gothenburg. They had been lame for an average of 42.3 days (range: 1-180 days) prior to surgery. All had instability (‘draw movement’) in the stifle and none of them had previously undergone surgery for cranial cruciate ligament rupture. The owners of the patients gave their consent for surgery and for active participation in the prospective study, and to bring the dogs back for follow-ups and treatment according to our written instructions.

The 39 dogs consisted of 15 male and 24 female dogs. They weighed between 25 and 50 kg, and their ages ranged from one to 12 years, with an average age of 5.8 years. Twelve different breeds were represented. The details of dogs included in the study are reported in Table 1.

**Operational technique**

All of the dogs were operated by the same surgeon, using the same operational technique.

An incision was made through the skin over the fascia lata to expose the lateral fabella and under the sartorius muscle to expose the medial fabella. The joint was examined by arthrotomy medially around the patella and the patellar ligament. Any torn meniscus was removed and the cruciate ligament remnants were excised. The joint capsule was removed and the cruciate ligament remnant was sutured using continuous polyglactin 910 suture. A 0.9 mm thick monofilament nylon thread was placed around the medial fabella and the origin of the medial gastrocnemius muscle. The thread was then passed through two holes drilled in the proximal tibial crest just cranial to the medial collateral ligament and round the lateral fabella and the origin of the lateral gastrocnemius muscle. The thread was stretched and secured with a fixing clip (40). The sartorius muscle was sutured to the patellar ligament with individual sutures of polypropylene. The fascia and subcutis were sutured separately with continuous Vicryl, Johnson & Johnson, New Brunswick, NJ, USA.

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**Table 1** Facts for the dogs in the study.

<table>
<thead>
<tr>
<th>nr</th>
<th>Breed</th>
<th>Age (years)</th>
<th>Days to surgery</th>
<th>Group</th>
<th>Kg</th>
<th>Special remarks</th>
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<tr>
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<td>43</td>
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<tr>
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<td>B</td>
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<td>17</td>
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* A = rehabilitation by physiotherapist, B = control group.
tinuous sutures of polyglactin 910a and the cutis with individual cross sutures using monofilament nylon.

A mixture of 2 ml morphinec and 8 ml bupivacaine (2.5 mg/ml) were then injected into the joint. An ice pack, left in place for two hours, was placed on the wound (31).

Postoperative care

All of the dogs where treated with cephalosporins and carprofene until the skin sutures were removed 14 days later. During this time the dogs were walked slowly on the leash.

Postoperative rehabilitation

The dogs who were assigned by chance into Group A (n=20) and Group B (n=19). The owners of dogs in both groups received the same written instructions regarding how to exercise their dogs, according to the following protocol. During the first two weeks, all of the animal owners were instructed to exercise their dog on the leash at a gentle walking speed on flat terrain three times a day for about 15 minutes. After two weeks, the leash exercise should be increased gradually to four 30-minute walks a day for a further four weeks. Between weeks six and 14, the walks should also be on uneven ground, and from week 15, the dogs should be allowed to exercise off the leash. In addition to the walks, the animal owners were also told to give their dogs muscle massaging and stretching.

The dogs in both groups came to the hospital for a check-up at 14 days after surgery to have the skin sutures removed. At this visit, the dog owners in Group A also received instructions from the physiotherapist. Group A dogs were given swimming training twice a week for four weeks, and then once a week for eight weeks. The animal owners were lent a transcutaneous electrical nerve stimulation (TENS) apparatus. The physiotherapist provided precise instructions regarding exercising on the leash, muscle massage and stretching, based on how the dogs had progressed.

Follow-up

The study lasted 24 weeks. Follow-up monitoring was carried out in weeks four, 12 and 24 postoperatively. The examination was carried out by the same two veterinary surgeons. In each instance, the degree of lameness, stability in the knee joint and the difference in muscle circumference in the two hind legs was noted.

The examination for lameness was performed while the patients were trotting and lameness was graded from 0 to 4. Thigh muscle circumference was measured, with a metric tape one third of the way up the femur (34). The difference in circumference between the two legs was noted. The measurements were carried out on the weight-bearing leg.

Stability was measured by a so-called ‘draw test’ performed with the dog lying on its side with the injured leg uppermost. Stability was graded from 0 to 4 (0 = too tight; 1 = normal stability, 2 = 2–3 mm drawer sign; 3 = 4–8 mm drawer sign; 4 = luxation of the knee).

VAS analysis

The animal owners were given a questionnaire in which they had to answer five questions about the condition of the dog before surgery and four, 12 and 24 weeks afterwards (41). Each owner was asked to give details of the dog’s level of activity, degree of handicap, stiffness after resting, any effect of the weather, as well as the dog’s ability to jump. The owners were asked to mark their response along a line scored from one end to the other using a ‘Visual Analog Scale’, whereby ‘0’ represents no function and ‘100’ represents perfect function. The questions in the VAS-analysis were the same as in reference 41.

Results

Preoperative examination

At the preoperative clinical examination, all of the dogs demonstrated lameness between grade 2 and 3 and draw movement between grade 2 and 4 (instability) in the knee joint. Thirty of the 39 dogs had a smaller muscle circumference in the injured leg compared with the contralateral leg. The difference was 0–6 cm for all of the dogs, and the mean value was 2.65 cm (Group A 2.15 cm and group B 3.14 cm).

Operation

Of the 39 dogs that were included in the study, 27 underwent surgery within a month of injury. Four of these had concomitant meniscal injury (dogs 2, 3, 8, 11). The remaining 13 had their operation one to six months after injury, and six of these dogs had concomitant meniscal injury (dogs 5, 15, 17, 22, 25, 36). The damaged menisci were removed during surgery.

Postoperative rehabilitation

We were able to follow up 30 of the 39 dogs for the 24-week follow-up period. Dog 9 was operated on the contralateral leg two years later and we have data recorded as dog 32 for its second surgery. Two of the dogs (dogs 12 and 39), whose menisci were judged to be normal at the time of the operation, were re-operated on at 16 and 17 weeks, respectively, after the first operation. Both had an injured medial meniscus which was dealt with in the second operation.

One dog (dog 13) was euthanatised two weeks after the operation, because of an infection in the joint which remained undetected at the acute stage. For various reasons, nine dogs failed to attend follow-up appointments at 24 weeks. Six of the owners were interviewed by telephone regarding the condition of their dogs at the end of the study. Three reported slight lameness and arthrosis, and three dogs were sound.
The result of the clinical examination carried out at the three follow-up visits showing the level of lameness is summarised in Fig. 1 (five dogs in group A and five dogs in group B showed slight lameness at 24 weeks). Muscle circumference is shown in Fig. 2.

At the examination carried out at 24 weeks after surgery, 28 of the 30 dogs demonstrated the same level of stability in the knee joint as in the contralateral (healthy) leg. Among these, 20 did not show any lameness, and 10 were slightly lame or stiff. Muscular mass was lost in the early postoperative period and was slowly regained afterwards. At four weeks there was still the same reduced amount of muscle mass as before surgery. At 12 weeks, mean values for group A were 1.47 and for group B 2.33, which showed that the dogs regained the same amount of muscle mass in both groups. At 24 weeks it was still less in 11 of the 30 dogs in the operated leg. Out of 11 dogs, seven dogs where in group A and four dogs where in group B. It takes a long time to regain muscle mass and the most important training seems to be walking on the leash.

No difference could be seen between the two groups A and B in the regaining of muscle mass postoperatively. Dogs that showed slight lameness at 24 weeks also had less muscle mass in the operated leg.

**VAS analysis**

Of the 39 questionnaires handed out, 26 (67%) were completed by the owners (41). The responses revealed that 24 weeks after surgery, 19 of the 26 dogs had regained their full, or almost full, level of activity. Of the remaining seven dogs, six were slightly lame and managing 50–80% of their full activity level, whilst one dog (dog 14) had only reached 20% of its full level of activity (Fig. 3).

**Discussion**

This study describes modification of an extra-articular technique used in 39 dogs with cranial cruciate ligament rupture. All of the dogs demonstrated considerable (grade 2-3) lameness and marked (grade 2-4) instability in the stifle before they had surgery.

The result of the operations showed that ‘good’ stability is regained using the technique studied. The explanation for the relatively good stability is probably the pressure achieved on the two fabellae and the fact that the suture is placed around the entire origin of the gastrocnemius muscle, on both the medial and lateral sides. The securing of the suture in the crista tibia avoids any interference with the patella ligament, and the hole in the tibial crest can be placed in a more plantar position. The placement of the suture around both fabellae protects from external rotation postoperatively. Two of the dogs that had undergone surgery had to be re-operated on during the study period. Both had experienced recurrent lameness which was found to be caused by meniscal injury. One dog (dog 13) came back 14 days postoperatively with a severe joint infection, a risk in all joint surgeries. The dog was euthanatised. The risk for infection should be minimised by proper surgical technique. Early detection of joint infection is crucial.

Previous studies had emphasised the importance of muscle-training after surgery (35-37), and so a control group was not employed.

The results revealed that there was not any difference between the two groups, which suggests that neither swimming training nor TENS improve or accelerate healing. We prefer to use the underwater treadmill Water Walker that provides proprioceptive training, which is more suitable than swimming training (reflex training) for cruciate rehabilitation.

The author’s subjective impression, after operating on some 500 dogs using the method...
described, is that the majority of dogs return to full capacity and can be used both as working and hunting dogs. In dogs with a body weight >50 kg, the outcome is probably not as good. To achieve a good outcome, surgery should be performed quite soon after injury and the dogs need to be exercised actively on the leash immediately after surgery.

Additional studies are required to establish which dogs with cranial cruciate ligament rupture should undergo surgery with external suture techniques, and which should undergo surgery with other techniques, such as TPLO (27, 33). Further investigations are also required in order to assess the value of post-operative rehabilitation following surgical treatment of cranial cruciate ligament rupture in dogs.

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