USE OF THE MODIFIED TOGGLE PIN TECHNIQUE FOR MANAGEMENT OF COXOFEMORAL LUXATION IN DOGS: A REVIEW OF LITERATURE AND A REPORT OF TWO CASES

R. Hõim, V. Andrianov, A. Lenzner

ABSTRACT. Use of the modified toggle pin technique for management of coxofemoral luxation in dogs: A review of literature and a report of two cases. *The surgical technique described in this paper is a modification of toggle pin stabilization, which is an intracapsular reduction technique for displaced hip. The modification involves a different prosthesis to replace the ligament of the head of femur (LHF), which was made by braiding together 4 strands of lavzane – a non-absorbable, polyester, multifilamentous suture material. The braiding makes the prosthesis extra stretchable and elastic, which makes it more resistant to tension. At the same time it allows articular mobility and good healing of the joint. The surgical approach and technique for use of toggle pin for LHF were similar to those that have been described. In both clinical cases, no bandage was used postoperatively, and the patients started to use the affected limbs immediately after surgery. No postoperative complications associated with the surgical technique or the material occured. Both dogs were fully recovered by 30 days, one of the dogs had no lameness at 10 days already. Radiographic images at 6–7 months revealed moderate degenerative changes in one case, that showed no progression in 3 years. No radiographic abnormalities were observed in the other dog.*

The modified toggle pin technique can maintain coxofemoral reduction and allow early weight-bearing. As it requires no postoperative immobilization of the coxofemoral joint, it is a particular advantage in those animals with multiple orthopedic injuries (especially of the contralateral limb).

According to the literature, the failure of the toggle pin technique occurs mostly due to the breakage of the suture. This modification might thus decrease the percentage of reluxation. Further studies are in progress to investigate the long-term efficacy of braided toggle material and the application of this method in different clinical cases.

Keywords: *traumatology, coxofemoral luxation, toggle pin technique.*

Coxofemoral luxation is a common traumatic disorder that accounts for 90% of all joint luxations in dogs (Özaydin *et al.*, 2003; Trostel *et al.*, 2000; Serdy *et al*., 1998; Meheust *et al*., 2001). The most common cause of acquired hip luxation is trauma, with motovehicle accidents accounting for approximately 60% (Slatter, 1993). The majority of hip luxations are craniodorsal, presumably because of the type of injury and contraction of the gluteal muscles, which are strong extensors and abductors of the hip joint (Slatter, 1993; Martini *et al*., 2001). Ventrocaudal displacements, where the femoral head may lodge within the obturator foramen, occurs less frequently. This type of luxation is often a result of a fall (Fossum, 1997). The hip may also luxate medially, in association with an acetabular fracture (Fossum, 1997).

The extent of soft-tissue damage that occurs with luxation depends on traumatic forces, direction of luxation, and duration of the luxation before definitive treatment (Slatter, 1993). The round ligament of the femoral head always fails completely; it may be an interstitial rupture or an avulsion of the ligament from the fovea capitis. The fibrous joint capsule must also be completely torn to permit dislocation of the femoral head (Denny, Butterworth, 2000).

Treatment of hip luxation should be performed as quickly as possible to prevent continued damage of the hip joint and degeneration of articular cartilage (Fossum, 1997; Brinker *et al*., 1990). Numerous surgical options exist for the management of hip luxations, and several papers have been reported on the success rates of these repairs. In general, greater success rates are reported with open reduction and surgical stabilization than with closed reduction, although closed reduction is the more common form of treatment (Trostel *et al.,* 2000; Fossum 1997). Closed reduction is performed under general anesthesia and the limb placed under Ehmer sling for 7 to 10 days to prevent recurrence (Özaydin *et al*., 2003; Serdy *et al.,* 1999). To further stabilize the hip joint, DeVita pinning (ischioilial pinning), flexible external fixation (Ellis pin), Yarbough pinning, and dynamic transarticular external skeletal fixation, have been used. These techniques have the advantage of minimal surgical intervention and trauma (Özydin *et al*., 2003; Slatter, 1993; Fossum, 1997; Serdy *et al.*, 1999; Denny, Butterworth, 2000). Reported failure rates for repair by closed reduction are 50 to 70% (Özaydin *et al.*, 2003; Meheust *et al.*, 2001). Consequently, open reduction techniques are favoured (Özydin *et al.*, 2003). Open techniques include intra- and extraarticular methods of stabilization. Intraarticular techniques rely on the reconstruction of the ligament of the head of the femur. Included in this group are transarticular pinning, toggle pin fixation, fascia lata loop stabilization (Özydin *et al.*, 2003; Slatter, 1993; Fossum, 1997; Serdy, *et al.*, 1999; Denny, Butterworth, 2000).

Extraarticular techniques rely on reconstruction or replacement of the extraarticular stabilizers of the hip, namely the joint capsule and muscular attachments. These techniques include joint capsulorrhaphy, transposition of the greater trochanter, anchor sutures, figure 8-shaped suture (prosthetic capsule reconstruction), triple pelvic osteotomy, excision arthroplasty, and total hip replacement (Brinker *et al.*, 1990; Özydin *et al.*, 2003; Serdy *et al.*, 1999; Meheust, 2001). The potential problems associated with open surgical treatment include recurrent luxation, implant migration or failure, neurologic damage, infection, and injury to the articular cartilage or periarticular tissues. However, open stabilization provides better stability and lower reluxation rates than nonsurgical methods (Serdy *et al.*, 1999).

The variety of surgical techniques described for coxofemoral luxation shows that there is no ideal method for repair (Martini *et al.*, 2001).

Toggle pin stabilization was originally described by Knowles in 1953 (Serdy *et al.*, 1999; Denny, Butterworth, 2000). It relies on a prosthetic replacement for the head of femur to maintain joint reduction until periarticular fibrous tissue has matured sufficiently to maintain reduction of the joint. This technique was initially advocated as a more physiological means of repair requiring no postoperative immobilization of the joint (Flynn *et al.*, 1994). The toggle pin itself serves as a bone anchor by locking against the medial wall of the acetabulum. The suture material secured to the toggle pin exits the acetabulum laterally at the site of the origin of the LHF and enters the femoral head at the site of insertion of the ligament. The suture transverses the femoral neck and diaphysis to exit on the lateral aspect near the third trochanter where it may be secured by various means (Serdy *et al.*, 1999). Proper placement of the suture should avoid cartilage damage and maximize biomechanical function of the prosthesis by closely mimicking the location of the original ligament (Serdy *et al.*, 1999).

In the following clinical cases, the surgical technique was similar to the original toggle pin stabilization, but the prosthesis material consists of 4 strands of non-absorbable heavy suture material braided together to form an elastic ligament.

Materials and methods

Dogs

Case 1. A 12 kg, 9 years old male poodle presented to the Small Animal Clinic of Estonian Agricultural University after being hit by a car 4 hours earlier. The dog was unable to use his right hind leg at all, the leg was held adducted, with some external rotation. The radiographic examination revealed left craniodorsal coxofemoral luxation.

Case 2. A 22 kg, 1 year old female husky was referred to the clinic with the history of non-weightbearing lameness of the left hindlimb. The dog had sustained a car accident 48 hours earlier. Left craniodorsal coxofemoral luxation was confirmed on initial radiographs.

In both cases the radiographic examination revealed no evidence of hip dysplasia or any degenerative joint disease involving the femoral or acetabular components.

Both patients had no concurrent orthopedic injuries.

Closed reduction failed in both cases.

Material

Toggle pin was constructed from 1.5 mm steel wire into which is fashioned a loop and placing the suture material through this according to the method described in veterinary literature (Denny, Butterworth, 2000; Flynn *et al.*, 1994). To replace the LHF a special prosthesis was made by braiding together 4 strands of non-absorbable heavy multifilamentous suture material – 8 USP lavzane (Figure 1). Lavzane is uncoated polyester material manufactured in Russia, it is close to Mersilene in its qualities. It has the advantages of being cheap, having good knot security and an excellent resistance to traction and we have not recorded tolerance problems using lavzane.

Surgical procedure

The dogs were premedicated with a mixture of medetomidine (0.01 mg/kg IV) and butorphanol tartrate (0.1 mg/kg IV). The patients were intubated and general anesthesia was maintained with halotane.

The patients were positioned in lateral recumbency with the affected limb up and prepared for aseptic surgery.

A craniolateral approach to the coxofemoral joint with partial tenotomy of deep gluteal muscle was performed. The acetabulum was cleared of debris, blood clots, fibrin, granulation tissue, and remnants of the ligament of the femoral head and the joint capsule.

The surgical technique is similar to those that have been described (Brinker *et al.*, 1990; Slatter, 1993).

A tunnel was drilled through the acetabular fossa with a 3.5-mm drill bit. The femoral head was rotated caudolaterally and a tunnel was drilled retrogradely from the fovea and down the femoral neck, to exit the femur just ventral to the greater trochanter. The femoral neck tunnel was drilled with a 3-mm drill bit.

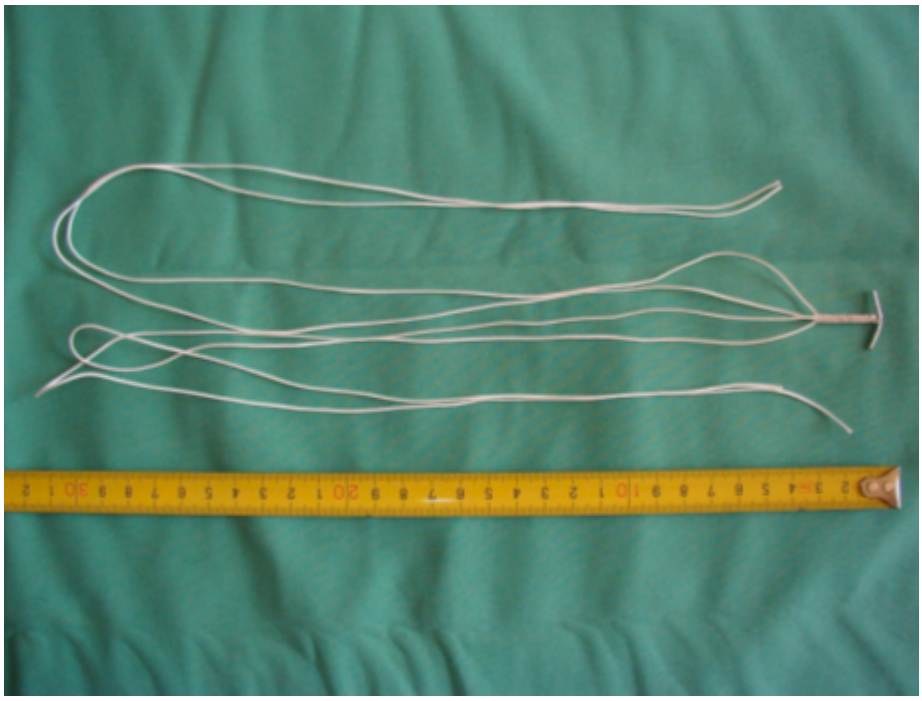

Figure 1. Prosthesis
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A second tunnel was drilled with a 2.5-mm drill bit transversely through the femur approximately 2–3 cm ventral to the femoral neck tunnel. The toggle was guided into the acetabular tunnel with artery forceps and then pushed into the pelvic canal where it engaged the medial wall of the pelvis as traction was applied. The ends of lavzane were drawn through the tunnel in the femoral neck with a wire loop and the femoral head was reduced. The unbraided part of the lavzane was divided into two parts, which were drawn through the transverse tunnel on either sides of the femur using a wire loop. The ends were tied securely on the lateral aspect of femur. The stability of the joint was checked by adducting the femur and pushing it craniodorsally. The remnants of the joint capsule were sutured and the surgical wound was closed in a routine manner, as described in veterinary literature (Brinker *et a1*., 1990; Slatter, 1993; Piermattei, 1993). Radiography to confirm adequate reduction was carried out.

Post-operative care

To manage postoperative pain, carprofen (Rimadyl, Pfizer) 4 mg/kg was administered once a daily for 5 days after surgery. Antibiotics were used in both cases: Amoxicillin with calvulanic acid (Synulox, Pfizer) 12.5 mg/kg SC 1 hour before the surgery following twice a day PO for 5 days.

No external support was used postoperatively. The dogs were encouraged to use the leg as soon as possible. Exercise was restricted for 2–4 weeks to walking.

Follow-up

The patients were clinically examined immediately after surgery, following 1, 10 and 30 days, 6–7 months and 1, 2 years (in one case also after 3 years) after the surgery. Clinical signs evaluated included pain, evidents of infection, crepitation, range of motion of the operated joint, lameness.

Radiographic examination was performed under sedation (Medetomidine 0.01 mg/kg IV and Butorfanol tartrate 0.1 mg/kg IV) immediately after surgery, 6–7 months and 1, 2 years after surgery (in one case also after 3 years). Standard ventrodorsal radiographic views of the pelvis were evaluated for reduction being maintained and the signs of coxofemoral degenerative joint disease (DJD).

Results

No intra- or postoperative complications associated with the surgical technique occurred in both dogs.

Case 1. The 9-year-old poodle started weight bearing on the affected limb on the first day after surgery. 10 days later the dog showed no lameness at all, there was no evidence of pain. The dog had a slight reduction of the range of motion. 30 days later the dog had normal gait, during manual extension and flexion of the hip joint no crepitation, laxity or reluxation was noted, the range of motion was normal. No palpable differences of the hip joint were detected between treated and untreated hind limbs. At 6 months, 1, 2 and 3 years postoperatively the function of the limb was excellent, no lameness had occurred according to the owner.

In the radiologic controls, 6 months later the coxofemoral reduction was maintained. The radiographs showed an osteophyte (approx. 3 mm) at the insertion of the joint capsule cranially, which indicates moderate DJD. During the follow-up period there was no progression of DJD radiographically.

Case 2. The 1-year-old husky started to use the operated limb on the next day after surgery. At 10 days the dog had some lameness. After 1 month no lameness was detected, maximal extension, flexion and rotation were painless and the range of motion of the operated joint was normal. During the follow-up period of 2 years reluxation did not occur and no complications associated with the surgical technique were encountered. The owner reported of no lameness even after heavy exercise (the dog has been used for hunting).

Radiographic evaluation (7 months, 1 and 2 years after surgery) showed good hip reduction with no evidence of DJD.

The clinical and radiographic follow-up demonstrated good long-term function of the affected hips.

Discussion

The two important components of a surgical technique for the repair of coxofemoral luxation are maintenance of reduction and restoration of normal joint motion in the long term (Martini *et al.*, 2001). No single open or closed treatment for coxofemoral luxation has been shown to be superior physiologically and biomechanically, many of these techniques can be considered satisfactory, but various complications are reported (Özaydin *et al.*, 2003; Martini *et al.*, 2001).

Results using toggle pin fixation have been variable, with reported rates of reluxation ranging from 7% to 29% (Serdy *et al.*, 1996; Meheust *et al.*, 2001; Flynn *et al.*, 1994). In those cases in which mode of failure was described, reluxation occurred via breakage of the suture prosthesis. A variety of materials have been used to replace the LHF included braided caprolactam, polyester, nylon, stainless steel wire, fascia lata and skin. The failure of the toggle pin itself also can occur (Flynn *et al.*, 1994).

The prosthesis used in our cases was prepared by braiding together 4 strands of non-absorbable multifilamentous polyester suture material (8 USP lavzane). Lavzane has good knot security and also the advantage of being cheap. The braiding makes it more stretchable and elastic, which increases its resistance to tension. At the same time it allows articular mobility and thus better capsular healing with formation of more functional tissue. Prolonged and rigid immobilization of a joint has long been recognized to be deleterious to periarticular tissues and to articular cartilage inducing proliferation of pericapsular connective tissue, capsular and pericapsular contracture, and major cartilage and subchondral bone alteration. The major concern about using non-absorbable material is the increased risk of infection and sinus formation. This type of complication is documented with surgery of different anatomic regions both in veterinary and human patients, but is not reported for surgical stabilization of coxofemoral luxations (Martini *et al.*, 2001).

The craniolateral surgical approach provided adequate exposure of acetabulum and femoral head. Subsequent reports of modifications describe an approach including osteotomy of the greater trochanter. (Brinker *et al.*, 1999; Piermattei, 1993). In our cases, osteotomy of the greater trochanter was not performed, thus minimizing surgical trauma and time. Partial capsulorrhaphies may have contributed to the successful outcome in the dogs.

Modified toggle pin method allows early return to function, that is a basic goal in orthopedic surgery. Limb disuse may be associated with muscle and cartilage atrophy, soft-tissue adhesions, an increased rate of postoperative infection, and potential long-term suboptimal performance of the affected limb (Slatter, 1993). A non-weightbearing sling was not used, the dogs were allowed to put weight on the affected limb immediately after surgery. This is an advantage in patients with multiple orthopedic injuries in which immediate use of the leg is necessary to allow the dog to ambulate. Using of toggle pin fixation without bandaging requires minimal postoperative care. During the follow-up period we observed early return of function in the affected limb and a quick return to normal gait. Reluxation did not occur and no complications associated with the surgical technique were encountered.

Radiographic evaluation revealed moderate DJD in one of the cases, but it does not hinder the animal in any way. Radiographic abnormality may have been due to trauma, and not to progressive DJD. The studies on the surgical treatment for coxofemoral luxation show that 50% of hips having undergone surgery develop arthrosis, but this process seems to be independent of the operative technique and is ascribable rather to the trauma of the accident. The success of the treatment does not prevent arthrosis. The severity of the arthrosis may be aggravated depending upon the quality of the repair and the surgical trauma (Meheust *et al.*, 2001; Evers *et al.*, 1997; Bone *et al*., 1984).

Conclusion

Toggle pin fixation is a practical technique, and requires no specific equipment. The technique may be satisfactorily used in dogs with coxofemoral luxation.

According to the literature, the toggle pin fixation fails mostly due to the breakage of the suture prosthesis. We believe that modifying the suture prosthesis in the way described in this study, the percentage of reluxation should decrease. Further studies are needed to investigate the long-term efficacy of braided toggle material and the application of this technique in different clinical cases.

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Modifitseeritud *toggle pin* fiksatsioon puusaliigese luksatsiooni ravis koertel: ülevaade kirjandusest ja kahe kliinilise juhu kirjeldus

R. Hõim, V. Andrianov, A. Lenzner

Kokkuvõte

Toggle pin (kinnitusnööriga varras *ingl. k.*) on tunnustatud operatiivse ravi meetod puusaliigese luksatsiooni raviks koertel. Meetodi olemus seisneb reieluupea ümarsideme asendamises proteesiga. Kirjanduse andmetel esineb klassikalise *toggle pin* meetodi puhul reluksatsiooni 7–25%. Enamikul neist juhtudest on ebaõnnestumise põhjuseks proteesi reieluukaela läbiva osa purunemine. Ümarsideme asendamiseks on kasutatud paljusid erinevaid materjale, näiteks kaprolaktaami, polüestrit, nailonit, roostevabast terasest varrast, plastikut, laisidekirmet (*fascia lata*) ja nahka. Käesolevas töös valmistati protees neljast lavsaanniidist (mitteresorbeeruv, multifilamentne õmblusmaterjal), mis omavahel kokku põimiti. Niisugune valmistamisviis muudab proteesi oluliselt elastsemaks ja venitatavamaks, mistõttu tõuseb tema resistentsus tõmbavale jõule. Samas võimaldab ta opereeritud liigese liikumist täies ulatuses, mis soodustab liigesekapsli funktsionaalsemat paranemist. Pikaajaline jäik immobilisatsioon kahjustaks oluliselt periartikulaarseid kudesid ja liigesekõhre, indutseerides perikapsulaarse sidekoe proliferatsiooni ja kapsli perikapsulaarsete kudede kontraktuuri ning tekitades muutusi kõhres ja subkondraalses luus.

Kasutatud materjal – lavsaan – on hea sõlmepidavusega ning odav. Mitteresorbeeruvate õmblusmaterjalide probleemiks on nii veterinaar- kui humaanmeditsiinilise kirjanduse andmetel oht infektsiooni ja uuriste tekkeks. EPMÜ Loomaarstiteaduskonna väikeloomakliinikus on neid tüsistusi registreeritud üliharva ning puusaliigese operatiivse reponeerimise järgselt üldse mitte.

Antud juhtudel kasutati operatsiooniks traditsioonilist kraniolateraalset juurdepääsu. Suure pöörla osteotoomiat, mida mõningad allikad selle operatsiooni juures kirjeldavad, antud juhtudel ei tehtud. Meie arvates on operatsioonivälja nähtavus niigi piisav ning puudub vajadus sellise lisatrauma tekitamiseks. Operatsiooni kulg ühtib käsiraamatutes kirjeldatud tavapärase *toggle pin* fiksatsiooniga. *Toggle pin* meetod kujutab endast puusanapa (*acetabulum)* mediaalsele seinale kinnitatud "ankrut", mille keskel olevast aasast pannakse läbi jämedast õmblusmaterjalist väät. "Ankur" on valmistatud roostevabast terasest vardast läbimõõduga 1,5 mm. Varda külge kinnitatud õmblusmaterjalist väät väljub puusanapast selle lateraalsel küljel ümarsideme lähtekohal ja siseneb reieluupeasse sideme kinnituskohal. Väät kulgeb läbi reieluukaela ja reieluu diafüüsi ning väljub reieluu lateraalsel küljel suurest pöörlast veidi ventraalsemalt. Mida täpsemalt on tunnel reieluukaela keskossa puuritud, seda vähem esineb liigesekõhre kahjustust kulumise tõttu ja seda enam jäljendab protees ümarsideme biomehaanilist funktsiooni. Järgnevalt puuritakse teine tunnel reieluusse risti eelnevaga, sellest 2–3 cm ventraalselt. Seejärel reponeeritakse reieluupea puusanappa. Proteesi punumata osa jagatakse kaheks ja viiakse läbi reieluutunneli, üks ühelt, teine teiselt poolt, ning sõlmitakse reieluu lateraalsel küljel.

Kirjeldatud operatsioon tehti kahel patsiendil. Nendeks olid 9-aastane isane puudel (kehamass 12 kg) ja 1-aastane emane laika (22 kg). Kummalgi koeral ei tekkinud lõikusest ega kasutatud materjalist tüsistusi. Mõlemad opereeritud koerad hakkasid jalale toetuma kohe pärast operatsiooni. Tugisidet ei kasutatud, et vältida lihasatroofiat selles piirkonnas. Täielik kliiniline paranemine saavutati mõlemal juhul ühe kuu jooksul, neist ühel ei täheldatud longet juba 10 päeva pärast operatsiooni.

Radioloogiline uuring tehti kohe pärast operatsiooni, veendumaks repositsiooni õnnestumises, ning 6–7 kuud, 1, 2 ja ühel juhul ka 3 aastat pärast operatsiooni. Ühel juhul (9-aastane puudel) esinesid 6 kuud pärast lõikust puusaliigeses mõõdukad degeneratiivsed muutused, mis ei avaldunud kliiniliselt. Need muutused on aga pigem seotud traumaga, sest ei ole progresseerunud ka 3 aastaga. Kirjanduses avaldatud uuringute tulemusena väidetakse, et 50% juhtudest areneb luksatsiooni tõttu opereeritud puusaliigeses artroos, mis ei sõltu operatsioonimeetodist. Teisel koeral radiogrammidel artrootilisi muutusi ei täheldatud.

Kokkuvõtteks võib öelda, et kirjeldatud modifikatsioon *toggle pin* fiksatsioonist on sobilik puusaliigese traumalise luksatsiooni raviks. Et meetod võimaldab varast jalale toetumist, on see eriti soodne kasutamiseks polütraumaga (eriti kontralateraalse jäseme vigastusega) patsientidel.

Kirjanduse andmetel ebaõnnestub *toggle pin* fiksatsioon peamiselt proteesi õmblusmaterjalist osa purunemise tõttu. Võimalik, et kirjeldatud modifikatsioon proteesist osutub seni kasutatutest vastupidavamaks ja vähendab seega reluksatsioonide hulka. Edaspidise uuringu eesmärgiks on selgitada, millised on operatsiooni hilisemad tulemused ning võrrelda neid teiste puusaliigese luksatsiooni ravis kasutatavate meetoditega.