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Comparative clinical efficacy between closed reduction (*Ehmer sling*) and open reduction (Toggle pin technique) for Hip luxation in dogs

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Abstract
The present comparative clinical study on repair coxofemoral joint luxation by closed reduction with Ehmer sling in 6 dogs and open reduction using Toggle pin technique in another 6 dogs which are presented for treatment at Department of Surgery and Radiology, College of Veterinary Science, Rajendranagar, Hyderabad. The coxofemoral joint luxation in dogs were subjected to routine clinical, orthopaedic examination and radiographic examination for diagnosis. The clinical signs of lameness, sudden onset of pain, deformity, creptus, and limited or abnormal movement of the limbs.

Coxofemoral joint luxation were confirmed by two perpendicular l radiographic views, lateral view of affected limb and Ventro-dorsal view of the Hip Joint. Radiography revealed 19 dog had craniodorsal luxation, 3 dogs ventral luxation, whereas Right side luxation in 8 dogs, left side luxation in 10 dogs and bilateral luxation in 2 dogs. Out of 20 dogs presented with coxomfemoral joint luxation, 6 dogs were selected for group I and treated with closed reduction applying ehmer sling as they are within 4 days of luxation. The other 6 dogs, in group II, not responded for closed reduction, were treated with Toggle pin (3.0 mm, 4.0 mm, 5.0 mm and 6.0mm) technique using polyester No. 5 non absorbable suture material in 6 dogs resulted in excellent stabilization.

Based on results it was concluded that in those dogs which are not responded to closed reduction, Open reduction using Toggle pin technique with polyester No.5 gives excellent stabilization and early limb function within 15 days post-surgery. Hence it is concluded that toggle pin technique is the gold standard for coxofemoral joint luxation in dogs.

Keywords: Hip luxation, Coxofemoral joint luxation, closed reduction, Ehmer sling, toggle pin technique, open reduction, dogs

Introduction

Hip dislocation or luxation is mostly due to trauma is a frequent condition in dogs and cats and generally due to vehicular accidents. Basher *et al.* (1986) [1] and Bone *et al.* (1984) [2] or falls from a great height. Hip Joint luxation is emergency clinical condition and should be addressed as early as possible for closed reduction.

Among the different type of coxofemoral luxations in dogs, Craniodorsal luxation is the most typical (Basher *et al.* 1986) [1]. Ventral or caudal direction luxation of femoral head occurs less commonly than craniodorsal luxation and may be paralleled with avulsion fractures of the greater trochanter. (Harari *et al.* 1984 and Schrader 1994) [5, 11].

Dogs with intra-articular fractures either proximal femur or acetabulum creates incongruity of the coxofemoral joint. In these cases closed reduction is not good option, whereas open reduction and rigid stabilization will restore the joint function. Appropriate case selection is important for closed reduction of coxofemoral joint luxation for not to occur relaxation, as relaxation rate is approximately 50%. To minimize cartilage destruction, muscle contraction and fibrosis of the joint space, joint reduction to be done as early as after injury. (Trostel *et al.* 2000, Piermattei *et al.* 2016) [13, 9].

Ehmersling is the most preferred method of maintaining hip joint reduction following successful initial closed reduction of a craniodorsal luxation. The purpose of the ehmer sling bandage will internally rotate, flex, and abduct the hip joint keeping the hind limb in a non–weight-bearing position. (Piermattei *et al.* 2016, Wardlaw and McLaughlin 2018 and Fossum 2019) [9, 7, 4].

For successful closed reduction of the hip luxation, it is to be is done in first few days after luxation preferably with in 24-48 hours. (Wardlaw and McLaughlin 2018) [7] if delayed for 4-5 days after luxation, reduction is more difficult.

If closed reduction is unsuccessful, open surgical reduction with toggle pin technique is attempted

For unstable hip joint, If closed reduction is not possible, open reduction and stabilisation with toggle pin fixation is attempted (Sissener *et al.* 2009, Cetinkaya and Olcay 2010, Piermattei *et al.* 2016, Wardlaw and McLaughlin 2018 and Fossum 2019) [12, 3, 9, 7, 4].

The aim of this comparative study was to report the results of a both closed reduction with ehmer sling and open reduction with toggle pin technique for craniodorsal luxation.

Materials and Methods

Anamnesis

The dogs (20) presented with coxofemoral joint luxation, ages ranges from 4 months to 96 months with a mean of 34±6.7 5. (Table.1) Out of these, 12 dogs were males and 8 dogs were females. Among these 12 dogs, were made two groups. The body weight ranged from 8 kg-15 kg with a mean of 12.33±1.05 Kg in group I, and from 10-25 kg with mean of 17±2.36 kg. in group II. Automobile accidents in six dogs (50.0%) and fall from height in six (50.0%) dogs are the main etiology for coxofemoral jont luxation. The dogs in group I were presented for treatment between 2-4 days after occurrence of coxofemoral luxaiton with a mean of 3.5±0.34 days. This in in accordance with Wardlaw and McLaughlin 2018 [7]. (Table. 2), whereas in group –II brought for treatment between 5-7 days after occurrence of coxofemoral luxaiton with a mean of 5.5±0.34 days. (Table.3). as reported by Wardlaw and McLaughlin 2018 [7] and Open reduction of the hip joint and maintenance of the hip joint with toggle pin is used when closed reduction is ineffective in maintaining reduction as reported by Çetinkaya, and Olcay 2010 [3].

Luxation of the femoral head is identified by Physical palpation using a thumb between the greater trochanter and the ischiatic tuberosity and rotating the femur externally.

Pre-operative radiographic observations

Diagnosis of coxofemoral joint luxation were confirmed by taking two perpendicular radiographic views, lateral view of affected limb and Ventro-dorsal view of the Hip Joint. Radiography revealed 19 dog had craniodorsal luxation, 3 dogs ventral luxation, whereas Right side luxation in 8 dogs, left side luxation in 10 dogs and bilateral luxation in 2 dogs. The list of dogs presented with coxofemoral joint luxation listed in Table 1.

Patient preparation

In group I, the dogs were sedated with xylazine hydrochloride (1mg/kg) plus ketamine (10mg/kg), the coxofemoral joint luxation and applied ehmer sling for 6 dogs.

For easy manipulation of hip joint, relaxation the muscles and elimination pain, the dogs were given general anesthesia and positioned in lateral recumbency with the affected limb uppermost.

The femoral head is disengaged from acetabular rim by grasping the limb and externally rotating the limb. Traction is then applied to the limb in a distocaudal direction to align the femoral head over the acetabulum. The limb is internally rotated and abducted to seat the femoral head into the acetabulum. Applying digital pressure on the greater trochanter will direct the femoral head into the acetabulum.

Full range of motion pressing medially with the help of greater trochanter to displace blood clots, joint capsule, and other soft tissues from the acetabulum. Joint stability is evaluated moving the hip joint, by femoral head flexion, extension, external rotation, and distraction.

After closed reduction of the femoral head, pelvic limb to be made non–weight-bearing by applying Ehmer sling or figure of eight bandage to maintain reduction. The femoral head within the acetabulum of hip joint will be kept in position by Ehmer sling. Non elastic adhesive tape is preferred material for bandage. Dogs with long hair coats needs to be shaved to keep the tape sling in place and to prevent slippage.

In group II, the dogs which were not responded for closed reduction through ehmer sling, were subjected to open reduction through toggle pin technique.

The site of operation was shaved and scrubbed. 5% povidine iodine solution was used to paint the site of operation of asepsis, followed by application of surgical spirit and the draping was done.

Anaesthesia

The combination of xylazine hydrochloride @ 1mg /kg and ketamine hydrochloride @ 10mg/kg was administered intramuscularly. Induction of General anesthesia was attained by injecting intravenous injection of Propofol @ of 4 mg/kg body weight after 10 minutes. Endotracheal intubation with suitable size after induction, maintenance with isoflurane @ of 2.5% in 100% oxygen for the throughout the surgical procedure.

Positioning of the Animal

The animal was positioned in lateral recumbency for the cranio-lateral approach with the affected limb up, which provided adequate exposure of the cranial and dorsal aspect of the femoral head and neck. Sterile drapes were used to maintain aseptic environment.

Materials used

Implants

In the present study indigenously made toggle pin diameter 3.0mm, 4.0 mm, 5.0 mm and 6.0mm were used along with polyester No. 5 for open reduction technique (Fig.1)

Surgical procedure

The craniolateral approach with curvilinear incision had provided a satisfactory exposure for coxofemoral joint. The skin incision was made just cranial to the greater trochanter and distally upto mid diaphysis of the femur. The cranial border of biceps was identified with tensor fascia latae and tensor fasica latae incised. The superficial borders of gluteal muscle were separated from the surrounding fascia and deep gluteus muscle was tenotomised up to middle of its tendinous insertion. Gelpi retractors and Senn retractors has provided satisfactory muscle separation. Along the long axis of the femoral neck at proximal ridge was incised to open the joint capsule. The incision was widened to a “T” shape at the dorsal rim of the acetabulum.

The remaining part of the round ligament from the acetabular fossa were incised. A drill bit of the corresponding size as per toggle pin to used for drilling a hole in the acetabular fossa. External rotation will facilitate inspection of the femoral head and round ligament was excised from the femoral head while the limb was held in 90 degrees. Using drill of corresponding size, hole drilled into the fovea capitis and in a line corresponding to the fovea capitis, a tunnel was drilled in the femoral head to the lateral sub trochanteric area.

A toggle pin with a central hole for attachment of polyester

No. 5 suture attachment and two wings to allow the pin to achor on the medial aspect of the acetabulum. The toggle pin along with polyester no. 5 suture was passed through the fovea capitis in to the medial side of the pelvis and then pulled back to anchor it to the medial aspect of the acetabulum. The polyester No. 5 suture material was passed from the femoral head and passing to the subtrochantric area by passing cerclege wire. A second hole is drilled at 90 degrees to the first tunnel in a cranio-caudal direction. By applying pressure, the femoral head reduced into the acetabulum and evaluated for full range of motion in order to displace any remaining joint-capsule remnants and debris from the joint space. The polyester No. 5 suture material ends were then passed through the second femoral tunnel; in a crossed manner and were tightened while assessing the joint stability and range of motion. Sutures were tightened so as not to occur relaxation. To limit the inter joint friction and arthritis in the joint, no excessive tension was applied while tying the knot. The joint capsule was closed with a simple suture and the operative wound closure was routine. (Fig.2)

Post-Operative care and management

A sterile pad with paint of Betadine solution was used to cover the incision line. Covered with cotton, gauge bandage over above, with final layer of surgical tape applied over the gauge bandage. The dressing and bandaging was changed every day up to the 12th post-operative day, based on the suture healing, removed sutures after 12th post-operative day. Injection of antibiotics and pain killer advised once per day for 5 days. Leash walk was advised to owners.

Post–operative radiograph observation

Post-operative radiographs were taken the day of surgery, 10 and 21st day after surgery shows femoral head position into the acetabulum.

Results and Discussion

The results of the present study age of the dogs presented with coxofemoral joint luxation ranges from 4 months to 96 months with a mean of 34±6.75. This findings are in accordance with Schlag *et al.* 2019 [10] and Todd *et al.* 2020. Out of these 12 dogs were males and 8 dogs were females. This is in accordance with Schlag *et al.* 2019 [10] and Trestel *et al.* 2020.

The dogs in group I were brought for treatment between 2-4 days after occurrence of coxofemoral luxaiton with a mean of 3.5±0.34 days. This in in accordance with Wardlaw and McLaughlin 2018 [7], whereas in group –II brought for treatment between 5-7 days after occurrence of coxofemoral luxaiton with a mean of 5.5±0.34 days as reported by Wardlaw and McLaughlin 2018 [7] and Open reduction and stabilization are also used when closed reduction is ineffective in maintaining reduction as reported by Çetinkaya, and Olcay 2010 [3].

Clinical examination, orthopaedic examination and physical examination along with radiography revealed 19 dogs had craniodorsal luxation, 3 dogs ventral luxation, whereas Right side luxation in 8 dogs, left side luxation in 10 dogs and bilateral luxation in 2 dogs (Fig.3). This is in congruence with the Brinker *et al.* 2016 [9] as reported as 78% of luxation in dogs. And caudo-ventral luxation occurs very rarely as reported by Harari *et al.* 1984. [5], and Schrader 1994 [11].

In group –I dogs, closed reduction, the post-reduction radiographs reveal the reduction of coxofemoral luxaiton, the femoral head into the acetabulum were in position. The ehmer sling were in place for 10-15 days and re-evaluated for the reduction in place. All six dogs had no complications, even after the removal of the ehmer sling, the dogs radio graphically evaluated for coxofemoral joint reduction. This findings are in accordance with Wardlaw and McLaughlin 2018 [7] whereas Schlag *et al.* 2019 [10] reported low success rate and Le Floch and Coronado 2021 reported 51% success rate with closed reduction. In view of the findings it is important for selection of case for closed reduction for higher success rate. The radiographs of six dogs pre and post, closed reduction and ehmer sling application presented in Fig. 4

In Group II, the dogs which were not responded for closed reduction and which are not suitable for closed reduction where selected for open reduction and applied toggle pin through craniolateral approach. The radiographs of pre and post-surgery were presented in fig. 5. The craniolateral approach with curvilinear incision had provided a satisfactory exposure for coxofemoral joint for easy application of toggle pin and polyester suture material No. 5 for holding the pin in position for reduction of femoral head into the acetabulum. This is in accordance with Çetinkaya, and Olcay 2010 [3], Brinker *et al.* 2016 [9], Hemick *et al.* 2018 [6], Wardlaw and McLaughlin 2018 [7].

Post –operative lameness grading done on regular basis on 7th, 15th and 21st day and all dogs showed no lameness, all dogs started bearing weight on 15th post-operative day. (Fig.6).

Table 1: History and Signalment of the dogs with coxofemoral joint luxations

S. No	Age of the dog (months)	Sex	Affected limb	Type of luxation
1	6	Male	Right	Craniodorsal
2	96	Female	Left	Craniodorsal
3	60	Male	Right	Craniodorsal
4	48	Male	Right	Craniodorsal
5	5	Male	Right	Craniodorsal
6	8	Female	Left	Craniodorsal
7	12	Male	Left	Craniodorsal
8	48	Female	Left	Craniodorsal
9	96	Male	Left	Craniodorsal
10	12	Male	Left	Craniodorsal
11	6	Female	Right	Craniodorsal
12	48	Male	Right	Craniodorsal
13	48	Male	Left	Craniodorsal
14	12	Female	Right	Craniodorsal
15	13	Male	Right	Craniodorsal
16	30	Female	Bilateral	R- craniodorsal L-ventral

17	4	Female	Left	Ventral
18	8	Male	Bilateral	R-Craniodorsal L- Ventral
19	48	Female	Left	Craniodorsal
20	72	Male	Left	Craniodorsal
	34±6.75	m-12 f-8	R-8 l-10 bilateral -2	19- craniodorsal 3- ventral

Table 2: Statement showing the list of dogs with coxofemoral joint luxation for closed reduction and application of Ehmer Sling

S. No	Age of the dog (months)	Weight	Sex	Affected limb	Type of luxation	Method of treatment	Results	Duration of luxation	Etiology
	Group I								
1	6	12	Male	Right	Craniodorsal	Closed reduction and emer sling	Good	2 days	Fall from height
Fall	96	15	Female	Left	Craniodorsal	Closed reduction and emer sling	Good	3 days	Fall from height
a	60	15	Male	Right	Craniodorsal	Closed reduction and emer sling	Good	4 days	Automobile accident
4	48	12	Male	Right	Craniodorsal	Closed reduction and emer sling	Good	4 days	Automobile accident
5	5	8	Male	Right	Craniodorsal	Closed reduction and emer sling	Good	4 days	Automobile accident
6	8	12	Female	Left	Craniodorsal	Closed reduction and emer sling	Good	4 days	Fall from height
	Mean ± standard error	Mean ± standard error						Mean ± standard error	
	37±15.22	12.33±1.05						3.5±0.34	

Table 3: Statement showing the list of dogs with coxofemoral joint luxation for open reduction with toggle pin technique

S. No	Age of the dog (months)	Weight	Sex	Affected limb	Type of luxation	Method of treatment	Results	Duration of luxation	Etiology
	Group-II								
1	12	12	Male	Left	Craniodorsal	Open reduction and Toggle pin 3mm with No. 5 Polyester	Good	5 days	Fall from height
2	48	10	Female	Left	Craniodorsal	Open reduction and Toggle pin 3mm with No. 5 Polyester	Good	7 days	Fall from height
3	96	15	Male	Left	Craniodorsal	Open reduction and Toggle pin 3mm with No. 5 Polyester	Good	5 days	Fall from height
4	12	18	Male	Left	Craniodorsal	Open reduction and Toggle pin 4 mm with No. 5 Polyester	Good	5 days	Automobile accident
5	6	22	Female	Right	Craniodorsal	Open reduction and Toggle pin 5 mm with No. 5 Polyester	Good	6 days	Automobile accident
6	48	25	Male	Right	Craniodorsal	Open reduction and Toggle pin 6 mm with No. 5 Polyester	Good	5 days	Automobile accident
	Mean ± standard error	Mean ± standard error						Mean ± standard error	
	37±14.06	17±2.36						5.5±0.34	

Fig 1: Toggle pin of different size diameter used in the study and polyester No. 5 suture material

Fig 2: Surgical procedure for toggle pin application in dog

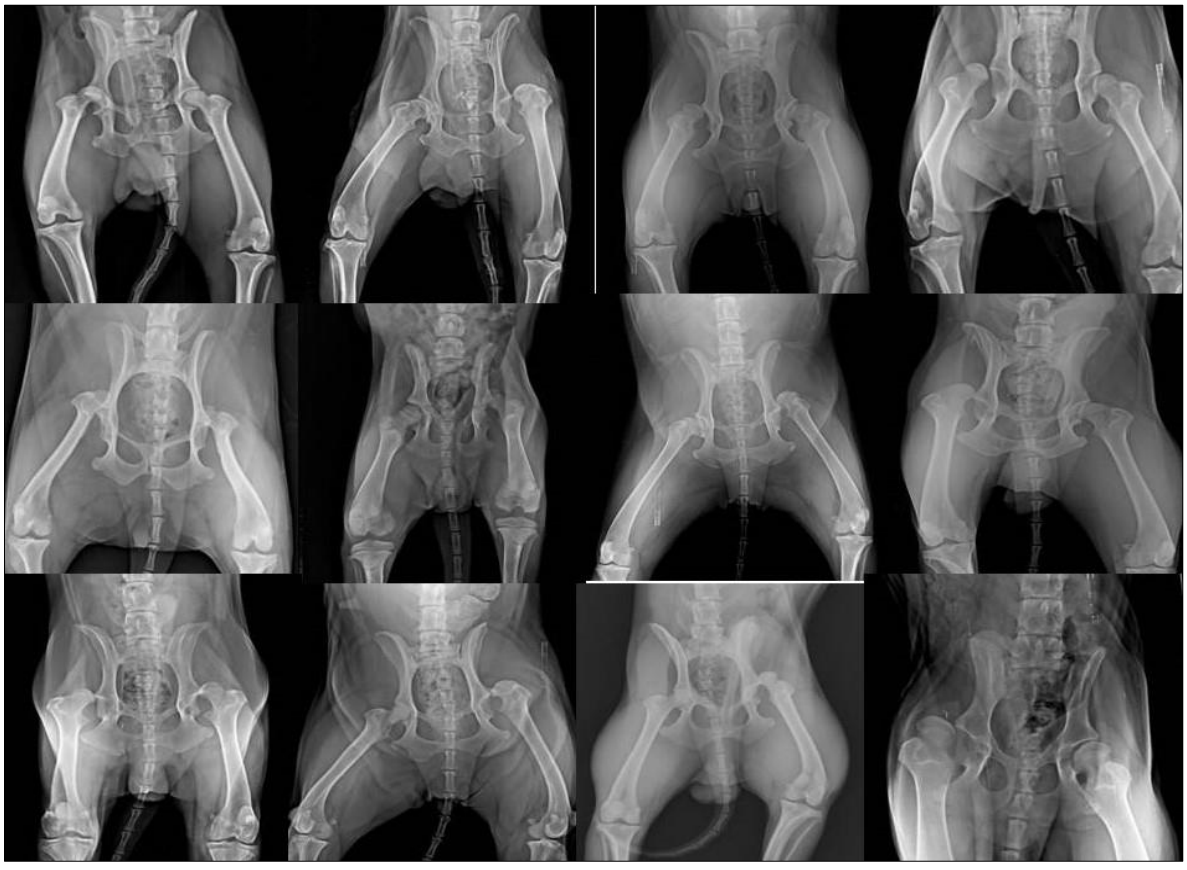

Fig 3: Pre-reduction radiographs showing different types of luxation in dogs

Fig 4: Showing the post reduction of closed coxofemoral luxation using Ehmer sling in dogs

Fig 5: Showing the post reduction of Open coxofemoral luxation using Toggle pin technique in dogs.

Fig 6: Showing weight bearing of dog after open reduction of coxofemoral joint luxaiton through toggle pin technique after 10 days of surgery

Conclusion

Based on present study it was concluded that in those dogs which are not responded to closed reduction, Open reduction using Toggle pin technique with polyester No.5 gives excellent stabilization and early limb function within 15 days post surgery. Hence it is concluded that toggle pin technique is the gold standard for coxofemoral joint luxation in dogs.

Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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