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Radiological comparison of different surgical techniques for hip dysplasia in dogs

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Abstract
Dogs with hip disorders viz, dysplastic hip, subluxated and luxated hips were radiographically studied with Hip extended ventrodorsal views and confirmed the dysplastic, osteoarthritic, subluxated and luxated hips. Excision arthroplasty was done in group I dogs where femoral head and neck was excised and joint capsule was sutured to prevent bone contact between femur and acetabulum. Denervation done in group II dogs wherein craniodorsal gluteal nerves on acetabular rim were destroyed using bone curette. Trans-femoral articular wiring was done in group III dogs for subluxated and luxated hips using nylon wiring. The dogs were followed up to 60 days. Radiological evaluation in group I revealed clear gap between acetabulum and excised femoral part. In group II dogs, apparently no change in radiographs were observed during study period. In group III, four dogs showed good apposition of acetabulum and head of femur and reluxation in certain dogs.

Keywords: Denervation, excision arthroplasty, trans-femoroarticular wiring

Introduction
Canine hip dysplasia is defined as a disease that stems from a varying degree of laxity of hip joint permitting sublimation during early life, giving rise to varying degrees of shallow acetabulum and flattening of femoral head, finally inevitably leading to osteoarthritis (Smith *et al*., 2012) [1]. Several methods have been proposed to measure passive laxity of hip joints in humans and dogs. No radiographic technique will completely eliminate false-positive and false-negative findings in obtaining a diagnosis of Canine hip dysplasia before onset of osteoarthritis (Gold *et al*., 2009) [2]. However, two radiographic methods Norberg angle and Distraction Index (i.e. NA and DI) are used most commonly in dogs. The NA measurement method applies to VD hip extended radiographs as a measure of quantify hip joint laxity (Gold *et al*., 2009) [2]. This paper present the radiological signs of hip dysplasia and the post-operative radiographic findings following the operative procedures namely excision arthroplasty, denervation and trans-femeroarticular wiring indogs.

Materials and Methods
The study was carried out among clinical cases suffering from hip dysplasia, luxation and subluxation presented to the surgical clinics. The dogs with hind limb lameness and altered gait were subjected to detailed physical, orthopaedic and radiological examination for conformation of hip dysplasia, subluxation and luxation. Radiological examination was done in ventrodorsal extended hip view and analyzed by Federation Cynologique International (FCI) scoring mode (Fluckiger, 2007) [3].

A total of 18 clinical cases of dogs with hip dysplasia were selected and divided into three groups of six dogs each for further. Dogs of age one year and above that are not responding to medical treatment were considered for excision arthroplasty procedure under standard anesthetic and operative procedures. Dogs with severe pain, higher body weight animals were considered for denervation procedure under standard anesthetic and operative procedures. Dogs with age one year and below one year, slightly dysplastic (increased joint space incongruent), subluxated and luxated hip were considered for trans-femeroarticular wiring procedure under standard operative procedures. All the dogs with hip dysplasia were subjected to ventrodorsal extended hip view with standard computerized radiography procedure (Care stream) and analysed by FCI scoring mode (Fluckiger, 2007) [3] as A, B, C, D and E and it was combined with the lameness grading based on clinical signs.

Results and Discussion

In group I Dogs, Preoperative venteodorsal radiograph of all six dogs except dog no.4 exhibited bilateral hip dysplasia, dog no. 1,2,3,4,5 and 6 exhibited Norberg angle of left and right limb as (90^0, 78^0), (101.2^0,103.5^0), (42^0,29^0), (100^0, 103^0), (92.6^0, 89.8^0), (94^0,98^0) respectively. Dog no. 3 showed hip dysplasia with luxation of left limb and subluxation of right limb. Luxation was seen in right limb of dog no.1 and dog no.6.Subluxation of hip joint seen in left limb in dog no.1, dog no.2 and 3 and in right limb in dog no. 3. (Table 1). Excision arthroplasty was performed in all the dogs under standard operative and anesthetic protocols as per the method mentioned by Piermattie and Johnson (1994) [4].

The curvilinear craniolateral incision on hip joint provided good visualization of hip joint severing round ligament of femur followed by ostectomy of femoral. In group II dogs, the Norberg angle ranged from 63.2^0 to 99^0 in left hip while it was 78^0 to 109.5^0 in right hip. Among six dogs selected, two limbs showed Norberg angle greater than 100^0, four limbs in the range of 90^0-100^0 two limbs in the range of 80^0-90^0 and four limb showed less than 80^0 (Table 2). Denervation of hip joint was performed in all the dogs under standard operative and anesthetic protocols as per the method of Kinzel *et al*., (2002) [5].

The dogs in this group were placed on lateral recumbency on the operation table with affected limb up and draped with a sterile drape to permit access to the craniodorsal aspect of the hip joint. A linear incision from trochanter major to iliac crest and reflection of gluteal muscle with Hohmann retractor provided good visualization of dorsal acetabular rim for denervation as per the procedure of Kinzel *et al*. (2002) [5]. Curetting and flushing of periosteal tissue with normal saline was done.

In group III dogs, the Norberg angle ranged from 89.8^0 to 101.6^0 in left hip while it was 28^0 to 106.8^0 in right hip. Among six animals selected, two limbs showed Norberg angle greater than 100^0, six limbs in the range of 90^0-100^0, two limbs in the range of 80^0- 90^0 and two limb showed less than 80^0 (Table 3). Trans-femoro articular wiring (group III) was performed in all the dogs under standard operative and anesthetic protocols as per the method of McCartney *et al*. (2011) [6]. Radiographs of the affected dogs provides information on the extent of luxation. All the dogs were anesthetized and the site prepared. C-arm guided tunneling of the acetabulum for passing of nylon wire around femoral head, acetabulum and percutaneous knotting over lesser ischiatic foramen stabilized the luxated and subluxated hip in trans-femero articular wiring in dogs. The ends of nylon wire were knotted percutaneously with triple knot.

In Excision arthroplasty performed dogs radiographically on day 1 Dog no.1,2,3,4 and 5 exhibited complete excision of femoral head and neck with portion of lesser trochanter (Fig.1). Dog no. 6 showed complete excision of femoral head with incomplete removal of the lesser trochanter whereas Day 7, the extended ventrodorsal hip radiograph of the dog showed wide gap observed between proximal femur and acetabulum. The extended ventrodorsal hip radiograph of the dog showed complete separation of proximal femur and acetabulum and remnants of lesser trochanter was evidently seen on day 15, 30 and 45 while in dog no. 6 remnants of lesser trochanter was evidently seen. In all the dogs except dog no. 6 showed complete gap between acetabulum and proximal part of femur and acetabulum where as in dog no. 6 bony proliferations were seen at lesser trochanter part (Fig. 2) by the end of 60th day. Separation of proximal femur and acetabular cavity and remnants of lesser trochanter was evidently seen on 30th, 45th and 60thdays in all the dogs. Off and Matis (2010) [7] and Srinivasamurthy (2015) [8] observed similar findings.

In the denervation group of dogs, no specific radiographic changes were observed during the period of study. Severe osteoarthritis with hip dysplasia seen in three dogs (Fig. 3) dysplastic hip seen in three cases preoperatively whereas post-operative radiographs taken on 1st day, 7th 15th, 30th, 45th and 60th days (Fig. 4) did not show any radiological changes. The dogs were followed up to one year. There was no worsening or improvement in the radiographic presentation. Rocha *et al*. (2013) [9] reported that there was no improvement in radiographic presentation six months after surgery. A longer study might be useful to evaluate the radiographic changes in the hip joints post operatively as suggested by Maruthi (2016) [10].

Radiographs form trans-femeroarticular wiring group of dogs on first post-operative day revealed, good alignment of femoral head into the acetabulum and nylon wire in situ (Fig.5). Radiographs on 7th post-operative day revealed air pockets in the area and suggesting severe infection and disruption of nylon wire in three dogs. Reluxation of femoral head with the acetabuluar rim was noticed on contrary to the findings of Shivkumar (2015) [11] and Amit (2016) [12]. In other three dogs the femoral head was in apposition with acetabulum and transarticular wiring was in situ. Radiographs on 15th post-operative day revealed good opposition with femoral head and acetabulum in four dogs and no arthritic changes were noticed. In other two dogs subluxation was observed which was not seen in the findings of Smitha (2014), Shivakumar (2015) and Amit (2016) [11, 12, 13].

Radiographs on 30th day revealed good apposition between head of femur and acetabulum whereas Osteoarthritic changes observed in two dogs. The nylon wire was removed on 30th day and positioning of acetabulum was observed in all dogs with slight subluxation in 2 dogs whereas Bennet and Duff (1980) [14] removed transarticular pin without any subluxation and McCartney *et al*. (2011) [6] observed osteoarthritis as common complication following modified transarticular pinning technique. The findings differ with Smitha (2014), Shivkumar (2015) and Amith (2016) [11, 12, 13].

Radiographs on 45th post-operative day revealed, good apposition between the head of the femur and acetabulum. Radiographs on 60th post-operative day revealed proper placement of the head of the femur into the acetabulum without any arthritic changes, no reluxation and nylon wire breakage (Fig. 6). Similar observations were Smitha (2014), Shivkumar (2015) and Amith (2016) [11, 12, 13]. Schachner and Lopez (2015) [15] stated that worldwide, there are five popular standardized evaluation systems with distinct metrics namely Orthopedic foundation for Animals, British Veterinary Association, Federation Cynologique internationale, Pennsylvania Hip improvement Programme and Dorsolateral luxation that are used to grade canine radiographic coxofemoral conformation and degenerative changes.

Table 1: Radiological assessment of cases selected for Excision Arthroplasty for Hip dysplasia in Dogs

Sl. No.	Breed	Limb involved	Norberg' Angle		Congruency of hip joint		Osteophytes present		Luxation		Subluxation		Degree of lameness
			Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	
1	Labrador	Bilateral	90^0	78^0	_	+	-	+	_	+	+	_	Grade III
2	Labrador	Bilateral	101.2^0	103.5^o	_	_	_	+	_	_	+	_	Grade III
3	German Shepherd	Bilateral	42^0	29^0	+	+	+	+	_	_	+	+	Grade IV
4	Labrador	Unillateral	105^0	100^0	_	+	_	_	_	_	_	_	Grade III
5	German Shepherd	Bilateral	92.6^0	89.8^0	+	+	+	+	_	_	_	_	Grade IV
6	Golden Retriever	Bilateral	94^0	98^0	+	_	+	+	_	+	_	_	Grade IV

I-Normal weight bearing on all limbs at rest and when walking.
II-Normal weight bearing at rest; favours affected limb when walking.
III-Partial weight bearing at rest and when walking.
IV-Partial weight bearing at rest; does not bear weight on affected limb when walking.
V-Does not bear weight at rest or when walking.
(+): Present (-): Absent.

Table 2: Radiological assessment of cases selected for Denervation for Hip dysplasia in Dogs (N=6)

Sl. No.	Breed	Limb involved	NA		Congruency of hip joint		Osteophytes present		Luxation		Subluxation		Degree of lameness
			Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	
1.	Spitz	Bilateral	99^0	78^0	+	+	+	+	_	_	_	_	Grade III
2.	German Shepherd	Unilateral	93^0	109.5^0	_	_	_	+	_	_	+	_	Grade III
3.	Rottweiler	Bilateral	92^0	89^0	_	_	_	_	_	_	+	+	Grade III
4.	Labrador Retriever	Bilateral	89^0	103^0	+	+	_	_	_	_	_	_	Grade IV
5.	Non-descript	Bilateral	97^0	78^0	_	_	+	+	_	_	_	_	Grade IV
6.	German Shepherd	Bilateral	63.2^0	68.7^0	_	_	+	+	_	+	_	_	Grade V

I-Normal weight bearing on all limbs at rest and when walking.
II-Normal weight bearing at rest; favours affected limb when walking.
III-Partial weight bearing at rest and when walking.
IV-Partial weight bearing at rest; does not bear weight on affected limb when walking.
V-Does not bear weight at rest or when walking.
(+): Present (-): Absent.

Table 3: Radiological assessment of cases selected for Trans-femoroarticular wiring for Hip dysplasia in Dogs (N=6)

Sl. No.	Breed	Limb involved	NA		Congruency of hip joint		Osteophytes present		Luxation		Subluxation		Degree of lameness
			Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	
1	Non-descript	Unilateral	99^0	28^0	+	_	_	_	_	+	_	_	Grade IV
2	Non-descript	Bilateral	101.6^0	106.8^0	_	_	_	+	_	_	+	_	Grade IV
3	German Shepherd	Unilateral	92^0	89^0	_	_	_	_	_	_	+	+	Grade III
4	Spitz	Bilateral	89.8^0	92.6^0	_	+	_	_	_	_	_	_	Grade V
5	Spitz	Unilateral	97^0	78^0	_	_	+	+	_	_	_	_	Grade IV
6	Pomeranian	Unilateral	94^0	98^0	_	_	+	+	_	+	_	_	Grade IV

I-Normal weight bearing on all limbs at rest and when walking.
II-Normal weight bearing at rest; favours affected limb when walking.
III-Partial weight bearing at rest and when walking.
IV-Partial weight bearing at rest; does not bear weight on affected limb when walking.
V-Does not bear weight at rest or when walking.
(+): Present (-): Absent.

Fig 1: Skiagram showing wide gap observed between proximal femur and acetabulum of left limb after excision arthroplasty (Group I, day 1)

Fig 2: Skiagram showing bony proliferations at lesser trochanter part of left femur Group I, day 60)

Fig 3: Skiagram showing severe osteoarthritis of both hip joints (Group II, preoperative day)

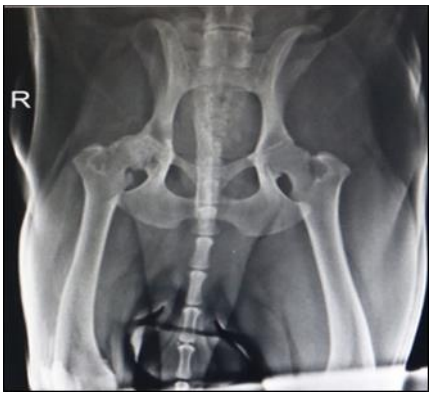

Fig 4: Skiagram showing no improvement of osteoarthritis of hip joints (Group II, day 60)

Fig 5: Skiagram showing apposition of femoral head with acetabulum (Group III, day 1)

Fig 6: Skiagram showing good apposition of femoral head with acetabulum (Group III, day 60)

Conclusion

In Conclusion grading of hip extended view using FCI grades, A, B, C, D and E combined with lameness grading based on clinical signs resulted in satisfactory results to evaluate the operative procedures.

Conflict of interest: Authors have no conflict of interest in this study.

Author's contribution: NN: Part of Ph.D. research article, MS: Ph.D. major advisor and guided the research programme, MSV: Minor Advisor and guided research at work place, NKBR: Advisory member in research work.

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