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# Evaluation of Hip Denervation with Supplementation of Epiitalis for Management of Hip Dysplasia in Canine

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## ABSTRACT

**Background:** Hip dysplasia is a common orthopedic disorder in dogs, particularly affecting large breeds and leads to progressive joint laxity and osteoarthritis. Pain arises from capsular stretching, periosteal irritation and muscular strain, resulting in lameness and impaired mobility. Management includes both surgical and non-surgical approaches; however, many provide only temporary relief. Hip denervation offers pain reduction by eliminating nociceptive input from the craniodorsal hip capsule, thereby improving comfort and limb function. Epiitalis oil, a plant-derived anti-inflammatory compound, enhances chondrocyte viability and reduces inflammatory mediators, making it a promising adjunct therapy for hip dysplasia.

**Methods:** The present study was conducted on eighteen clinical cases of moderate hip dysplasia to evaluate the efficacy of hip denervation and Epiitalis oil in management. Animals were randomly allocated into three groups (A, B and C; n=10 each). The group A received Epiitalis oil orally at 4 µL/kg for 10 days, the group B underwent surgical denervation of the craniodorsal surface of the hip; and the group C received both denervation and Epiitalis oil orally at 4 µL/kg for 10 days. Treatment efficacy was assessed using clinico-physiological and radiological parameters.

**Result:** Physiological parameters remained within normal ranges and showed non-significant inter- and intra-group variations. Scores of various physical tests, including weight bearing, gait analysis, hind limb extension test, bipedal station test, hip function test and Ortolani's test, decreased progressively over time, indicating functional recovery. Weight-bearing scores decreased in all groups, with significant reductions observed in Groups B and C at multiple intervals compared to baseline. Gait scores improved significantly from day 15 in Group C and by day 45 in Group B. Ortolani test scores decreased progressively in Groups B and C, becoming significant after day 30. Radiographic scores showed non-significant improvement at different intervals compared to baseline values. Hip denervation is a simple, safe and effective technique for the management of mild to moderate hip dysplasia. However, combined treatment with hip denervation and oral Epiitalis oil was the most effective, demonstrating earlier and greater functional improvement compared to hip denervation or oral Epiitalis oil alone.

**Key words:** Epiitalis oil, Hip denervation, Hip dysplasia, Norberg angle, Ortolani test.

## INTRODUCTION

Hip dysplasia (HD) is an inherited, non-congenital orthopedic disease with a reported high incidence and heritability of up to 95% in the canine species. It is more prevalent in large and giant dog breeds (Guo *et al.,* 2011). The condition is characterized by degenerative joint changes that can progressively lead to osteoarthritis (OA) in the affected joints (Smith *et al.,* 2001). Significant alterations in acetabular and femoral head parameters in dysplastic hips occurred (Kataru *et al.,* 2022). The most common clinical signs include joint pain and gait abnormalities such as stiffness, reduced step height, shortened stride length, bunny hopping and difficulty in rising, climbing stairs, or jumping over obstacles (Ginja *et al.,* 2008). Pain during movement arises from multiple sources, including stretching and inflammation of the joint capsule, contracture of the hip adductor muscles and periosteal sensitization due to osteophyte formation.

Treatment modalities include both non-surgical and surgical interventions. Non-surgical management consists of adequate nutrition, body weight reduction, physiotherapy, pain control, nutraceuticals and chondroprotective medications (Corr, 2007). Recent studies have emphasized the role of biochemical markers such as serum hyaluronic acid for early detection of osteoarthritic changes in young dogs affected with hip dysplasia, thereby aiding in early

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intervention and management (Kataru *et al.,* 2023). Surgical options include pectineal myectomy, femoral neck lengthening, triple pelvic osteotomy, hip denervation, dorsal rim acetabuloplasty, total hip replacement and excisional hip arthroplasty (Fries and Remedios, 1995). Total hip replacement using cemented prosthetics has been reported to significantly improve limb function and quality of life in dysplastic dogs under Indian clinical conditions (Venkatesh *et al.,* 2024). The canine hip joint capsule receives articular innervation from four major nerves: the cranial gluteal nerve, sciatic nerve, femoral nerve and obturator nerve (Huang *et al.,* 2005). The craniolateral region of the hip joint capsule is subjected to greater tension and contains the highest density of pain receptors.

Denervation of the craniolateral surface of the hip joint facilitates physical conditioning of the hip and thigh muscles, thereby strengthening the dysplastic joint; however, the structural lesions caused by dysplasia and their progression remain unchanged (Gasse *et al.,* 1996). This procedure improves animal comfort by providing pain relief and restoring joint and limb function, reducing the need for analgesic medications. Epiitalis is a proprietary oil extract derived from *Biota orientalis* and an active ingredient of 4CYTE Canine, administered orally to relieve pain in dogs with osteoarthritis (Pearson *et al.,* 2012). It significantly inhibits interleukin-1-induced prostaglandin E and nitric oxide production and enhances chondrocyte viability. The present study evaluated the effects of hip denervation and Epiitalis in the management of canine hip dysplasia.

## MATERIALS AND METHODS

The research work was conducted on eighteen clinical cases with a history of hind limb(s) lameness and moderate hip dysplasia, presented to the Department of Veterinary Surgery and Radiology, Bihar Veterinary College, Patna. The dogs were randomly selected irrespective of age, sex, breed and weight and were subjected to various treatment protocols. Written consent was obtained from the owners to include their animals in the study. Eighteen animals diagnosed with hip dysplasia were randomly distributed into three equal groups. Animals in Group A received Epiitalis oil orally at a dose of 4 µL/kg for 10 days. In Group B, surgical denervation of the craniodorsal surface of the hip joint was performed. In Group C, denervation of the craniodorsal surface of the hip joint was combined with oral administration of Epiitalis oil at a dose of 4 µL/kg for 10 days.

### Surgical procedure

All animals in Groups B and C were premedicated with atropine sulphate @ 0.04 mg/kg IM and xylazine @ 1 mg/kg IM, followed by induction with ketamine @ 5 mg/kg and maintenance with a ketamine–diazepam combination. The animals were restrained in lateral recumbency with the affected limb positioned uppermost (Fig 1). A 4-5 cm long dorsolateral incision was made between the greater trochanter and the iliac crest (Fig 2). The subcutaneous fat and fascia between the tensor fascia lata and biceps femoris muscles were separated. Finally, the triangular space formed by portions of the biceps femoris, middle gluteal and tensor fascia lata muscles was exposed (Fig 3). A retractor was introduced along the dorsal margin of the ilium to retract the middle gluteal muscle dorsally, thereby exposing the cranial and dorsal aspects of the acetabular rim. Surgical denervation was performed by removing the periosteum from the craniodorsal aspect of the acetabular rim (Fig 4) by scraping with a periosteal elevator and a modified bone curette in a semicircular manner, extending from the cranial-dorsal margins of the articular capsule to the ventral margin of the ilium (Fig 5). Finally, muscle, subcutaneous tissue and skin (Fig 6) were sutured. Postoperatively, all animals were treated with inj. ceftriaxone combined with tazobactam at a dose rate of 25 mg/kg IV at 12-hour intervals for 7 days and inj. meloxicam at a dose of 0.2 mg/kg on the first day followed by 0.1 mg/kg IM



**Fig 1:** Animal was controlled in lateral recumbency.

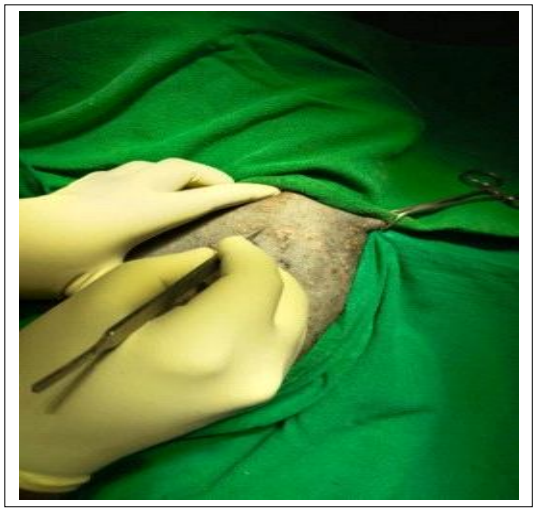


**Fig 2:** Incision in-between greater trochanter and iliac crest.

for the next 2 days. Sutures were removed on the 10th postoperative day.

**Evaluation and data collection**

Physiological parameters, including rectal temperature (°F), heart rate (beats/min) and respiratory rate (breaths/min), were recorded prior to surgery and on the 15th, 30th and 45th days of treatment. Physical and clinical examinations, including weight bearing, hind limb extension test, abduction with external rotation test, bipedal station test, ability to jump and climb, hip function test, gait analysis and Ortolani's test, were performed before surgery and on the 15th, 30th and 45th days of treatment. Weight-bearing scores were assessed according to Impellizeri *et al.* (2000). For the hind limb extension test, the hind limbs of awake, standing animals were extended to the maximum limit tolerated and responses were graded on a 1-5 scale as described by Kim *et al.* (2009) at the same time points. The ability to jump was evaluated during walking or running and graded on a 1-5 scale following Soares *et al.* (2016), while the ability to climb stairs was assessed and graded on a 1-5 scale as per Soares *et al.* (2016). Gait was evaluated on a 1-4 scale in accordance with Peter *et al.* (2013).

For the bipedal station test, dogs were made to bear their body weight on the hind limbs by elevating the forelimbs and responses were graded on a 1-4 scale following Peter *et al.* (2013). The Ortolani test was performed in lateral recumbency with the affected limb uppermost and the femur held parallel to the examination table. The stifle was gradually abducted to reduce the hip joint and the presence of a palpable or audible "clunk" on reduction was recorded as positive. Grading was done on a 1-3 scale according to Ortolani (1976). The hip function test was performed in lateral recumbency by manipulating the hip joint through flexion, extension and abduction to evaluate range of motion and responses were scored as per Impellizeri *et al.* (2000). Radiographic evaluation was performed using ventrodorsal, extended-leg views prior to surgery and on days 15, 30 and 45, following the method described by Farese *et al.* (1998). Nine anatomical features were assessed: Norberg angle, subluxation, dorsal edge of the acetabulum, cranial edge of the acetabulum, caudal

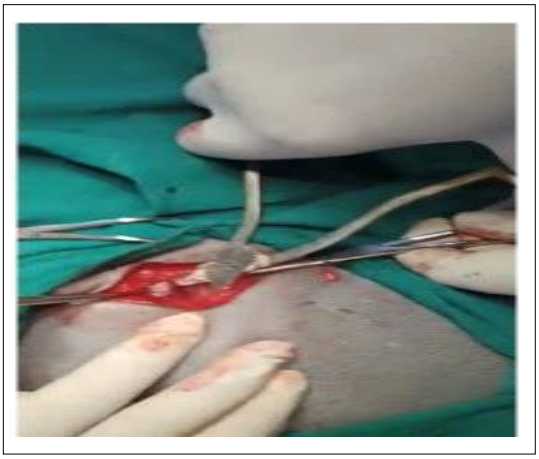


**Fig 3:** Triangle formed by portion of biceps femoris, middle gluteal muscle and tensor fascia latae.



**Fig 5:** Removing the periosteum from craniodorsal aspect of acetabular rim.



**Fig 4:** Scraping acetabular rim.



**Fig 6:** Skin suture.

edge of the acetabulum, acetabular fossa, cranial effective rim of the acetabulum, exostosis of the femoral head and neck and recontouring of the femoral head. The BVA/KC score was calculated as the sum of scores for all nine features for both hips and radiographs were graded on a 0-6 scale according to BVA/KC guidelines.

**Statistical analysis**

Statistical analyses were carried out using SPSS software (version 20; Statistical Package for the Social Sciences). A probability level of $p<0.05$ was considered statistically significant. Quantitative variables were evaluated by two-way analysis of variance (ANOVA), followed by Duncan's Multiple Range Test (DMRT) for post-hoc comparisons. For ordinal or scoring data, within-group variations were assessed using the Wilcoxon signed-rank test with baseline (day 0) values as reference. Between-group comparisons were performed using the Kruskal-Wallis test. Descriptive statistics including mean, standard error, median, minimum and maximum values were also calculated.

## RESULTS AND DISCUSSION

There were no statistically significant differences in rectal temperature, heart rate, or respiratory rate between or within groups at different periods of the study. These parameters remained within the normal physiological range in all dogs across the three groups throughout the entire observation period. Weight-bearing scores decreased at different intervals in all three groups (Table 1). However, in Groups B and C, significant reductions in scores were observed at various intervals compared to baseline values. Inter group comparison revealed that weight-bearing scores were significantly lower in Group C at postoperative intervals throughout the observation period. Similarly, gait scores decreased at different intervals in all groups (Table 1), but significant improvement was observed from day 15 onward in Group C, whereas in Group B, a significant reduction was observed on day 45. The ability-to-jump scores showed non-significant changes in Groups A and B at different intervals compared to baseline values (Table 1). However, in Group C, the ability-to-jump score became significantly lower from the 15$^{th}$ postoperative day and remained significantly lower compared to baseline throughout the observation period. Scores for the ability to climb stairs in Groups A and B showed non-significant changes at various intervals, whereas scores in Group C gradually decreased and became significant by the 45$^{th}$ postoperative day.

Scores of hind limb extension decreased non-significantly in the group A whereas significantly in groups B from 30$^{th}$ onward and in group C from 15$^{th}$ onward post-operatively in comparison to base values (Table 1). The score of bipedal test was decreased non -significantly at different interval in group A in comparison to base values (Table 2). Whereas score reduced gradually in the group B and C and became significantly lower at 30$^{th}$ days onwards. Similarly score of Ortolani test and hip function test were decreased non-significantly at different interval in the group A in comparison to base values. In groups B and C the score of ortolani test was gradually decrease and become significantly lower at postoperatively 30$^{th}$ day and remained significantly lower up to observation period in comparison to base values (Table 2).

Radiographs were evaluated for Norberg angle, subluxation, dorsal acetabular edge, cranial acetabular edge, caudal acetabular edge, acetabular fossa, cranial effective acetabular rim, femoral head and neck exostosis and femoral head recontouring. Radiographic grading of hip dysplasia was done according to BVA scheme. Radiographic evidence of degenerative joint disease includes osteophytes on the cranial or caudal acetabular margin, femoral peri articular osteophyte formation, subchondral sclerosis of the craniodorsal acetabulum. The BVA values of groups A, B and C non-significantly changed at different intervals within the groups and in-between groups (Table 3).

**Table 1:** Mean±SD values of weight bearing all the three groups at different time intervals.

| Parameters | Groups | 0$^{th}$ day | 15$^{th}$ day | 30$^{th}$ day | 45$^{th}$ day |
|---|---|---|---|---|---|
| Weight bearing | A | 2.33±0.52 | 2.33±0.52$^{B}$ | 2±0$^{B}$ | 2±0$^{B}$ |
| | B | 2.5±0.55$^{b}$ | 1.83±0.41$^{abAB}$ | 1.33±0.52$^{aAB}$ | 1.33±0.52$^{aAB}$ |
| | C | 2.5±0.55$^{b}$ | 1.5±0.55$^{aA}$ | 1±0$^{aA}$ | 1±0$^{aA}$ |
| Score of gait | A | 2.33±0.52 | 2.33±0.52 | 2±0$^{B}$ | 2±0$^{B}$ |
| | B | 2.5±0.55$^{c}$ | 2±0$^{bc}$ | 1.33±0.52$^{abAB}$ | 1.17±0.41$^{aA}$ |
| | C | 2.5±0.55$^{b}$ | 1.67±0.52$^{a}$ | 1±0$^{aA}$ | 1±0$^{aA}$ |
| Score of ability to jump | A | 2.33±0.52 | 2.33±0.52$^{B}$ | 1.67±0.52 | 2±0$^{B}$ |
| | B | 2.67±0.52 | 2±0$^{AB}$ | 1.83±0.41 | 1.5±0.55$^{AB}$ |
| | C | 2.67±0.52$^{b}$ | 1.5±0.55$^{aA}$ | 1.17±0.41$^{a}$ | 1.17±0.41$^{aA}$ |
| Scores of ability to climb stairs | A | 2±0.9 | 2±0.9 | 1.67±0.52 | 1.67±0.52 |
| | B | 2.33±0.52 | 1.5±0.84 | 1.33±0.52 | 1.33±0.52 |
| | C | 2.5±0.55$^{b}$ | 2±0$^{ab}$ | 1.33±0.52$^{ab}$ | 1.17±0.41$^{a}$ |
| Hind limb extension | A | 2.33±0.52 | 2±0.89 | 1.67±0.52 | 2±0$^{B}$ |
| | B | 2.33±0.55$^{b}$ | 1.5±0.55$^{a}$ | 1.33±0.52$^{a}$ | 1.17±0.41$^{aA}$ |
| | C | 2.5±0.55$^{b}$ | 1.5±0.55$^{ab}$ | 1.17±0.41$^{a}$ | 1±0$^{aA}$ |

Physiological parameters were within the normal physiological range in all dogs of three groups during entire observation period. This indicated that hip dysplasia and treatment methods adopted in all three groups had no effect on rectal temperature, heart rate and respiratory rate. This may be because hip dysplasia is a localized disease of the hip joint. Similarly, Ranganath and Subin (2006) also reported non-significant difference in the rectal temperature, heart rate and respiratory rate in dogs with and without hip dysplasia.

Scores of various physical examination tests tended to decrease over time, indicating functional improvement in the animals. Most animals in Group C showed earlier improvement compared to the other groups. Improvements in weight bearing, gait and ability to climb stairs may be attributed to pain relief and improved joint stability. Similar to the present study, Lister *et al.* (2019) reported improvement in weight bearing following coxofemoral denervation in 10 dogs suffering from hip dysplasia and osteoarthritis; however, improvement was observed in only 50% of the animals. This difference in results may be due to the inclusion of all categories of hip dysplasia or variability in the presence of obturator nerve branches (Staszyk *et al.,* 2002). The ability to climb stairs was evaluated using a numerical rating scale as suggested by Impellizeri *et al.* (2000). Clinical evaluation of canine hindquarter and locomotor weakness has shown that improvement in functional gait and weight bearing can be achieved with appropriate surgical and therapeutic interventions (Sharma *et al*., 2013). Improvement in climbing ability may be due to pain relief and enhanced joint stability. Ferrigno *et al.* (2007) also reported a significant improvement in stair-climbing ability in 63.91% of dogs seven days after denervation surgery.

Similarly, the reduction in scores of the hind limb extension test, bipedal station test and Ortolani test may be attributed to decreased hip joint pain and improved joint function following surgery. Rocha *et al.* (2013) also reported that 60% of dogs showed pain reduction within seven days and 80% within one month after hip denervation. The earlier reduction in hind limb extension scores observed in Group C may be due to the combined effect of hip denervation and Epiitalis oil. Ginja *et al.* (2008) described the Ortolani test as a commonly used physical manipulation technique for diagnosing hip joint laxity in dogs. Increased hip joint laxity is caused by delayed muscular development along with increased synovial effusion (Chalman and Butler, 1985).

The present study revealed no significant differences in radiographic score improvement either between or within the three groups. Rocha *et al.* (2013) also reported no radiographic improvement up to six months following surgery.

However, no radiographic worsening of the condition was observed and an important finding was the visible reduction in the space between the acetabulum and the femoral head, with increased coverage of the femoral head by the acetabular rim. In the present study, the follow-up period was limited to 45 days. A longer follow-up period would be required to evaluate radiographic changes occurring in the hip joint(s). Regeneration of articular cartilage, if it occurred as a result of denervation and Epiitalis oil administration, was not evident on conventional radiographs. Advanced imaging modalities, such as magnetic resonance imaging (MRI), may be required to detect subtle articular changes.

Surgical denervation of the hip joint was found to offer several advantages, including technical simplicity of the procedure and ease of periosteal removal, allowing the technique to be performed by any surgeon without special training or specialized instruments. The simplicity of the procedure makes it particularly suitable for both very young and geriatric dogs. The denervation technique is advantageous in these age groups due to its short surgical duration and brief convalescent period. The low cost of denervation benefits many owners, as it provides a viable surgical alternative to long-term drug therapy, which is often associated with higher costs and potential side effects. The hip joint and its capsule are not directly involved in the

**Table 2:** Mean±SD values of bipedal test of animals in different groups at various time intervals.

| Parameters | Groups | $0^{th}$ day | $15^{th}$ day | $30^{th}$ day | $45^{th}$ day |
|---|---|---|---|---|---|
| Bipedal test | A | 2.33±0.52 | 2±0 | $2±0^{B}$ | $2±0^{B}$ |
| | B | $2.33±0.52^{b}$ | $2±0^{b}$ | $1±0^{aA}$ | $1±0^{aA}$ |
| | C | $2.33±0.52^{b}$ | $1.67±0.52^{b}$ | $1.33±0.52^{aAB}$ | $1.33±0.52^{aAB}$ |
| Hip function test | A | 2.67±0.52 | 2.33±0.52 | 2±0 | 2±0 |
| | B | $2.67±0.52^{b}$ | $2±0^{ab}$ | $1.67±0.52^{a}$ | $1.33±0.52^{a}$ |
| | C | $2.5±0.55^{b}$ | $2±0^{ab}$ | $1.5±0.55^{a}$ | $1.33±0.52^{a}$ |
| Ortolani test | A | 2±0 | 1.99±0 | $1.97±0^{B}$ | $1.97±0^{B}$ |
| | B | $2.33±0.52^{b}$ | $2±0^{b}$ | $1.33±0.52^{aA}$ | $1.33±0.52^{aA}$ |
| | C | $2.33±0.52^{c}$ | $1.67±0.52^{b}$ | $1±0^{aA}$ | $1±0^{Aa}$ |

**Table 3:** Mean ± SD values of BVA score of animals in different groups at various time intervals.

| Group | $0^{th}$ day | $15^{th}$ day | $30^{th}$ day | $45^{th}$ day |
|---|---|---|---|---|
| Group A | 43.5±2.3 | 43.2±2.5 | 42.8±2.2 | 41.9±2.9 |
| Group B | 44.2±2.1 | 43.17±2.17 | 41.9±1.83 | 39.89±1.98 |
| Group C | 43.4±1.71 | 42.83±2.85 | 40.89±1.78 | 39.8±1.73 |

surgery; therefore, in the event of treatment failure, routine reconstructive and salvage procedures are not compromised by prior denervation. Similar advantages of denervation surgery have been reported by Kinzel *et al.* (2002) and Whiteside *et al.* (2006).

## CONCLUSION

Hip denervation is a simple and safe technique for the management of mild to moderate hip dysplasia. It reduces pain and improves joint function in cases of moderate hip dysplasia. Epiitalis oil alone is not significantly effective in moderate hip dysplasia; however, oral supplementation combined with hip denervation leads to earlier improvement in clinical signs.

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### Disclaimers

The authors confirm that the views and conclusions expressed in this article are solely those of the authors and do not necessarily reflect the views of their affiliated institutions. The authors take full responsibility for the accuracy and completeness of the information presented and disclaim any liability for direct or indirect losses arising from the use of this content.

### Informed consent

The animal study protocol was approved by the Institutional Animal Ethics Committee (IAEC) of Bihar Veterinary College, Patna. Informed consent was obtained from all subjects involved in the study.

### Conflict of interest

The authors declare that there are no financial or non-financial conflicts of interest related to this study.

## REFERENCES

Chalman, J.A. and Butler, H.C. (1985). Coxofemoral joint laxity and the Ortolani sign. *Journal of the American Animal Hospital Association.* **21(5):** 671-676.

Corr, D., Accardi, M., Graham-brady, L. and Shah, S. (2007). Digital image correlation analysis of Interfacial debonding properties and fracture behavior in concrete. *Engineering Fracture Mechanics*. **74(1-2):** 109-121.

Farese, J.P., Todhunter, R.J., Lust, G., Williams, A.J., Dykes, N.L. (1998). Dorsolateral subluxation of hip joints in dogs measured in a weightbearing position with radiography and computed tomography. *Veterinary Surgery.* **27:** 393-405.

Ferrigno, C.R.A., Schmaedecke, A., Oliveira, L.M., D'Avila, R.S., Yamamoto, E.Y. and Saut, J.P.E. (2007). Cranial and dorsal acetabular denervation technique in treatment of hip dysplasia in dogs: 360 days' evaluation of 97 cases. *Brazilian Journal of Veterinary Research*. **27(8):** 333-340.

Fries, C.L. and Remedios, A.M. (1995). The pathogenesis and diagnosis of canine hip dysplasia: A review. *The Canadian Veterinary Journal*. **36(8):** 494.

Gasse, F., Fontes, J.C., Van Campo, E. and Wei, K. (1996). Holocene environmental changes in Bangong Co basin (Western Tibet). Part 4: Discussion and conclusions. *Palaeogeography, Palaeoclimatology, Palaeoecology*. **120(1-2):** 79-92.

Ginja, M., Llorens-Pena, M., Gonzalo-Orden, J. and Ferreira, A. (2007). Mechanical devices to help in Penn HIP examination. *Acta Veterinaria Hungarica*. **55(2):** 199-205.

Ginja, M.M.D., Gonzalo-Orden, J.M., Melo-Pinto, P., Bulas-Cruz, J., Orden, M.A., San Roman, F. and Ferreira, A.J.A. (2008). Early hip laxity examination in predicting moderate and severe hip dysplasia in Estrela Mountain Dog. *Journal of Small Animal Practice*. **49(12):** 641-646.

Guo, G., Zhang, Z., Zhou, Z., Wang, Y., Zhao, K., Zhu, L., Lust, G., Hunter, L., Friedenberg, S., Li, J., Zhang, Y., Harris, S., Jones, P., Sandler, J., Krostscheck, U., Todhunter, R. and Zhang, Z. (2011). Canine hip dysplasia is predictable by genotyping. **19(4):** 420-429.

Huang, J.I., Kazmi, N., Durbhakula, M.M., Hering, T.M., Yoo, J.U. and Johnstone, B. (2005). Chondrogenic potential of progenitor cells derived from human bone marrow and adipose tissue: A patient-matched comparison. *Journal of Orthopaedic Research*. **23(6):** 1383-1389.

Impellizeri, J.A., Tetrick, M.A. and Muir, P. (2000). Effect of weight reduction on clinical signs of lameness in dogs with hip osteoarthritis. *Journal of the American Veterinary Medical Association*. **216(7):** 1089-1091.

Kataru, J.M.R., Podarala, V., Venkata, S.K.R., Mukku, S.L. and Jampala, V.S. (2023). Serum hyaluronic acid- an effective biomarker for early detection of osteoarthritis in young dogs with canine hip dysplasia. *Indian Journal of Animal Research*. doi: 10.18805/IJAR.B-5054.

Kataru, J.M.R., Podarala, V., Venkata, S.K.R., Mukku, S.L. and Jampala, V.S. (2022). Morphometry of Hip Joint in German shepherd Dogs with Hip Dysplasia *Vis* a *Vis* Normal Hip. *Indian Journal of Animal Research*. **60(3):** 485-492. doi: 10.18805/IJAR.B-4941.

Kim, D., Kim, C.H., Moon, J.I., Chung, Y.G., Chang, M.Y., Han, B.S. and Kim, K.S. (2009). Generation of human induced pluripotent stem cells by direct delivery of reprogramming proteins. *Cell Stem Cell.* **4(6):** 472.

Kinzel, S., Scheven, C.V., Buecker, A., Stopinski, T. and Kupper, W. (2002). Clinical evaluation of denervation of the canine hip joint capsule: A retrospective study of 117 dogs. *Veterinary and Comparative Orthopaedics and Traumatology*. **15:** 51-56.

Lister, R., Pelizzola, M., Dowen, R.H., Hawkins, R.D., Hon, G., Tonti-Filippini, J. and Ecker, J.R. (2019). Human DNA methylomes at base resolution show widespread epigenomic differences. *Nature.* **462(7271):** 315-322.

Ortolani, M. (1976). Congenital hip dysplasia in the light of early and very early diagnosis. *Clinical Orthopaedics and Related Research*. **119:** 6-10.

Pearson, P.J. and Fouquet, R. (2012). Past and prospective energy transitions: Insights from history. *Energy Policy*. **50:** 1-7.

Peter, A.H., Rocha, M., Bullock, J.S. and Kaplinghat, M. (2013). Cosmological simulations with self-interacting dark matter-II. Halo shapes versus observations. *Monthly Notices of the Royal Astronomical Society.* **430(1):** 105-120.

Ranganath, L. and Subin, K. (2006). Hip scoring in dogs. *Indian Journal of Veterinary Surgery*. **27(2):** 116-118.

Rocha, L.B., Tudury, E.A., Roehsig, C., Barauna, D., Chioratto, R., Araujo, F.P. and Kemper, B. (2013). Hip joint denervation in dogs with degenerative joint disease secondary to dysplasia. *Brazilian Animal Science.* **14(1):** 120-134.

Sharma, A.K., Gupta, O.P., Singh, G.R., Pawde, A.M. and Maiti, S.K. (2013). Occurrence, clinical and radiographic study of hindquarter weakness in dogs. *Indian Journal of Animal Research.* **47(3):** 259-261.

Smith, G.K., Mayhew, P.D., Kapatkin, A.S., McKelvie, P.J., Shofer, F.S. and Gregor, T.P. (2001). Evaluation of risk factors for degenerative joint disease associated with hip dysplasia in German Shepherd Dogs, Golden Retrievers, Labrador Retrievers and Rottweilers. *Journal of the American Veterinary Medical Association*. **219(12):** 1719-1724.

Soares, E.C., Guimarães-Paiva, A., Lima-Santos, E., Moreira-Pereira, S., Santana-Santos, E., Almeida, E.O. and Silva, T.J. (2016). Potential of carapeba (*Eugerres brasilianus*) for aquaculture production. *Latin American Journal of Aquatic Research*. **44(4):** 718-725.

Staszyk, C., Gasse, H., Wenda, T. and Hackbarth, H. (2002). Topography of nerve branches to the canine hip joint. *Anatomia, Histologia, Embryologia*. **31(1):** 17-21.

Venkatesh, N., Reddy Mohan Jagan, K., Chandra Sekhar, E.L. and Rajendranath, N. (2024). A clinical study on total hip replacement using cemented prosthetics for management of hip dysplasia in dogs. *Indian Journal of Animal Research.* **58(8):** 1283-1293. doi: 10.18805/IJAR.B-5217.

Whiteside, D.P., Remedios, A.M., Black, S.R. and Finn-Bodner, S.T. (2006). Meloxicam and surgical denervation of the coxofemoral joint for the treatment of degenerative osteoarthritis in a Bengal tiger (*Panthera tigris*). *Journal of Zoo and Wildlife Medicine*. **37(3):** 416-419.