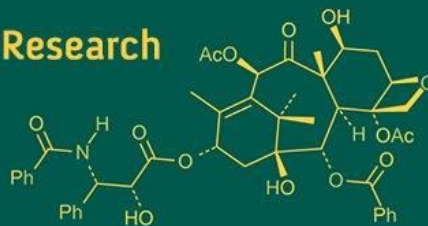
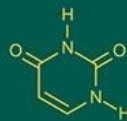
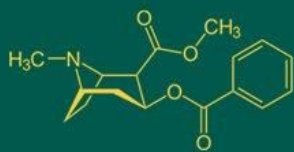


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Integrated therapeutic strategies for managing canine hip osteoarthritis

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Abstract

The present clinical study was conducted on 24 clinically and radiographically confirmed canine hip osteoarthritis cases. Dogs were divided into 4 groups (n=6) and treated with different protocols. Group 1 received pentosan polysulfate sodium (PPS) (3.3 mg/kg S/C for 4 weeks), oral nutraceuticals for 4 weeks, and carprofen (4 mg/kg PO for 7 days). Group 2 underwent physiotherapy alone for 4 weeks. Group 3 received a combination of PPS, nutraceuticals, and physiotherapy for 4 weeks. Group 4 was treated with femoral head and neck ostectomy followed by postoperative physiotherapy for 4 weeks. Hip osteoarthritis was most common in females (54.2%), dogs aged 6-10 years (62.5%), Labrador Retrievers (62.5%), dogs weighing 31-40 kg (50%), those with a body condition score of 7 (37.5%), and bilateral hip involvement (79.17%). Clinical assessment included radiographic evaluation, pain on palpation, joint motion, weight bearing during standing, and lameness during walking on day 0 and day 28. Scores were highest at presentation but significantly improved after treatment in all groups. The greatest improvement occurred in the combined medicinal and physiotherapy group, followed by the surgical group, medicinal only group, and physiotherapy only group. The marked improvement in the combined group highlights the therapeutic effectiveness of PPS, nutraceuticals, and physiotherapy in managing canine hip osteoarthritis. Dogs undergoing femoral head and neck ostectomy with postoperative physiotherapy showed satisfactory recovery and functional limb use. Medicinal therapy and physiotherapy alone also produced favourable outcomes, demonstrating their roles in reducing pain, improving mobility, and enhancing quality of life.

Keywords: Osteoarthritis, Pentosan polysulfate sodium, Physiotherapy, Femoral head and neck ostectomy

Introduction

Osteoarthritis (OA) is a chronic degenerative joint disease-causing pain, stiffness, swelling, and lameness due to cartilage deterioration and synovial joint changes (Vaughan-Scott & Taylor, 1997; Pasquini *et al.*, 2003) [14, 20]. It affects cartilage, synovial fluid, and bone, often leading to synovial inflammation and osteophyte formation. OA management aims to reduce pain, control inflammation, slow degeneration, and improve mobility. A multimodal approach is essential, combining nutraceuticals, physiotherapy (ultrasound, thermotherapy, laser, electrical stimulation), and pharmacological treatments such as NSAIDs and glycosaminoglycans.

Pentosan Polysulfate Sodium, a heparin-like glycosaminoglycan, is widely used for OA management. It helps reduce inflammation and has shown promise in clinical trials for non-infectious arthritis, effectively preserving cartilage proteoglycans (Suheb *et al.*, 2015) [18]. Excision arthroplasty, or femoral head and neck ostectomy (FHO), is a salvage procedure used for painful hip conditions such as dysplasia, Legg-Calve-Perthes disease, OA, chronic luxation, fractures, or failed hip surgeries (Ganesh *et al.*, 2017; Harper, 2017) [5, 6]. By removing the femoral head and neck, it creates a pseudoarthrosis that reduces pain and restores comfortable mobility (Sutradhar *et al.*, 2019) [19]. Physiotherapy has been used in veterinary medicine for over 25 years, and companion animal rehabilitation is now a rapidly growing specialty with increasing scientific support (Millis, 2015) [9]. Hence, the present research work was undertaken with the following objective: (1) To evaluate the efficacy of physiotherapeutic management alone and or in combination with medicinal management in

hip joint osteoarthritic dogs. (2) To evaluate the efficacy of femoral head and neck ostectomy followed by physiotherapy in hip joint osteoarthritic dogs.

Managing Canine Hip Osteoarthritis” included 24 canine cases at Department of Veterinary Surgery and Radiology, Kamdhenu University, Anand. Dogs were divided into four groups (n=6) and treated with different protocols.

Materials and Methods

The present study “Integrated Therapeutic Strategies for

Table 1: Different protocol for present study.

Group	Therapy	Treatment
Group I (n=6)	Medical Management	Inj. Pentosan Polysulfate Sodium (3.3 mg/kg S/C once weekly for 4 weeks) + Oral Nutraceuticals + Tab. Carprofen (@ 4.4 mg/kg for 7 days)
Group II (n=6)	Physiotherapy	Therapeutic Ultrasound (TU), Infra-red radiation therapy (IRT), Low-Level Laser Therapy (LLLT), Pulsed Electromagnetic Field Therapy (PEMF), Transcutaneous Electrical Nerve Stimulation (TENS), Passive Range of Motion (PROM), Therapeutic Exercise (TE), and Neuromuscular Electrical Stimulation (NMES) for 28 days
Group III (n=6)	Medical Management + Physiotherapy	Inj. Pentosan Polysulfate Sodium (3.3 mg/kg S/C once weekly for 4 weeks) + Oral Nutraceuticals + TU, IRT, LLLT, PEMF, TENS, PROM, TE, NMES for 28 days
Group IV (n=6)	Surgical Management + Physiotherapy	Femoral Head and Neck Ostectomy + TU, IRT, LLLT, PEMF, TENS, PROM, TE, NMES

To evaluate efficacy of this protocols different parameters were recorded like Radiographic evaluation (RE), Pain on palpation (PP), Joint motion (JM), Weight bearing during standing (WBS), and Lameness during walk (LW).

Table 2: Clinical history of dogs selected for present study in group 1.

Case No.	Breed	Sex	Age (Year)	B. wt (Kg)	BCS (1-9)	Limb
1	Shiatzu	Male	3	6.5	5	Bilateral
2	Golden Retriever	Female	6	30.5	6	Bilateral
3	Labrador Retriever	Male	9	35.8	7	Right
4	Rottweiler	Male	9	39.1	7	Bilateral
5	Labrador Retriever	Female	8	40	7	Bilateral
6	Labrador Retriever	Female	8	33.6	6	Bilateral

Table 3: Clinical history of dogs selected for present study in group 2.

Case No.	Breed	Sex	Age (Year)	B. wt (Kg)	BCS (1-9)	Limb
1	Labrador Retriever	Male	13	48.5	8	Bilateral
2	Labrador Retriever	Male	14	50	8	Bilateral
3	Labrador Retriever	Female	13	38.5	7	Left
4	Labrador Retriever	Male	10	50.6	8	Right
5	Labrador Retriever	Female	4	45	8	Bilateral
6	Labrador Retriever	Female	4	59.6	9	Bilateral

Table 4: Clinical history of dogs selected for present study in group 3.

Case No.	Breed	Sex	Age (Year)	B. wt (Kg)	BCS (1-9)	Limb
1	Labrador Retriever	Female	6.5	35	7	Bilateral
2	Labrador Retriever	Female	12	38.7	7	Bilateral
3	Rottweiler	Female	7	33.5	6	Right
4	Labrador Retriever	Female	9	38.2	7	Bilateral
5	Labrador Retriever	Female	6	40.4	7	Bilateral
6	Labrador Retriever	Female	7	35.3	7	Bilateral

Table 5: Clinical history of dogs selected for present study in group 4.

4	Breed	Sex	Age (Year)	B. wt (Kg)	BCS (1-9)	Limb
1	German Shepherd	Male	8	28	5	Bilateral
2	German Shepherd	Male	8.5	30.5	5	Bilateral
3	German Shepherd	Male	3.5	27.6	5	Right
4	Golden Retriever	Male	3.5	24.5	5	Bilateral
5	Labrador Retriever	Female	6	28.4	5	Bilateral
6	Labrador Retriever	Male	7.5	31.5	5	Bilateral

The dogs will be positioned in ventrodorsal depending on the hip joint examination. Radiographs will be interpreted to identify any structural changes or abnormalities indicative of OA (McCarthy *et al.*, 2007)^[8].

Table 6: Radiographic evaluation was recorded on a scale of 0-3 as;

Grade	Clinical evaluation
0	Not affected
1	Doubtful narrowing of joint space and possible osteophytic lipping
2	Definite osteophytes and possible narrowing of joint space
3	Large multiple osteophytes, definite narrowing of joint space, some sclerosis and possible deformity of bone contour

The degree of pain was assessed by palpating the affected limb or joint and graded according to the criteria described by McCarthy *et al.* (2007) ^[8].

Table 7: Pain on palpation was recorded on a scale of 0-3 as;

Grade	Clinical evaluation
0	No sign of pain
1	Mild pain on palpation (Dog turns head in recognition)
2	Moderate pain with slightly withdrawal of limb
3	Sever pain immediate limb withdrawal

The degree of joint motion was assessed by checking range of motion of the affected limb or joint and graded according to the criteria described by McCarthy *et al.* (2007) ^[8].

Table 8: Joint motion was recorded on a scale of 0-3 as;

Grade	Clinical evaluation
0	Full range of motion
1	Mild limitation (10-20%) in range of motion; no crepitus
2	Moderate limitation (20-50%) in range of motion; $\pm$ crepitus
3	Severe limitation (>50%) in range of motion; $\pm$ crepitus

The degree of weight bearing of the affected limb was evaluated and the following grades were given as per McCarthy *et al.* (2007) ^[8].

Table 9: Weight bearing during standing was recorded on a scale of 0-3 as;

Grade	Clinical evaluation
0	Equal weight bearing on all forelimbs
1	Partial weight bearing while standing and walking
2	Partial weight-bearing standing; non-weight-bearing walking
3	Non-weight-bearing standing and walking

The degree of lameness was assessed by walking and trotting the animals over a distance of 6 meters, repeated three times. The lameness was graded according to the scale described by McCarthy *et al.* (2007) ^[8].

Table 10: Lameness during walk was recorded on a scale of 0-3 as;

Grade	Clinical evaluation
0	Not detectable; walk normally
1	Intermittent slightly lame when walking
2	Persistent severely lame when walking
3	Persistent non-weight bearing

All the dogs were assessed and scored given based on radiographic evaluation (RE), pain on palpation (PP), joint motion (JM), weight bearing during standing (WBS), and lameness during walk (LW) on the day of presentation and 28th post therapeutic day.

A. Radiographic examination	B. Radiographic signs of hip OA
C. Pain on palpation	D. Joint motion
E. Weight bearing during standing	F. Lameness during walk

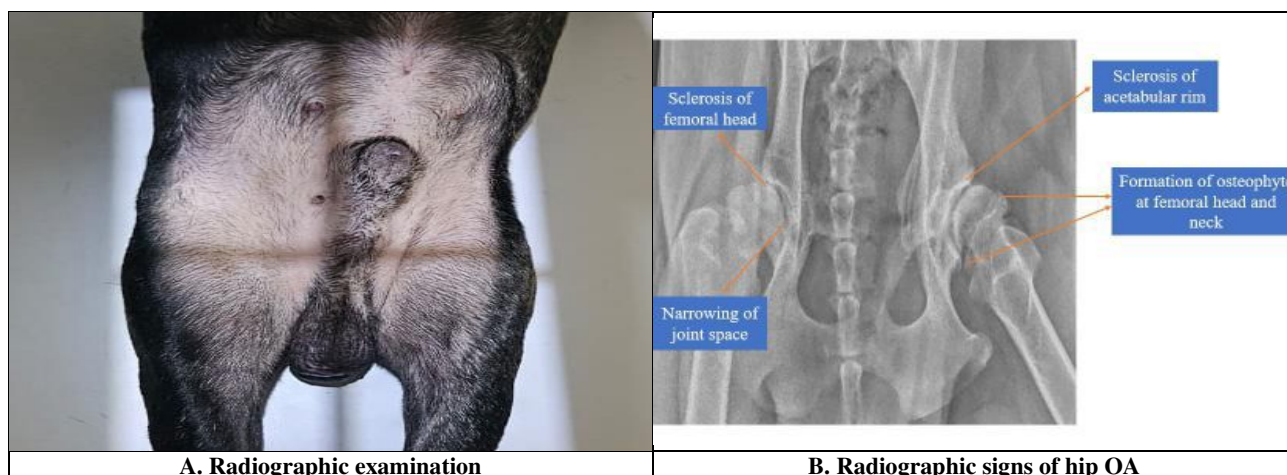




Fig 1: Clinical Parameter Examined

Results and discussion

Clinical Parameter of Group 1

All dogs were evaluated for radiographic changes, pain on palpation, joint motion, weight bearing, and lameness using a 0-3 grading scale (McCarthy *et al.*, 2007) [8] on day 0 and day 28. Mean±SE scores at presentation were 2.33±0.21 (RE), 1.33±0.21 (PP), 1.83±0.30 (JM), 1.33±0.33 (WBS), and 1.67±0.21 (LW). By day 28, these improved to 1.50±0.22, 0.33±0.21, 0.67±0.21, 0.33±0.21, and 0.67±0.21, respectively, indicating significant therapeutic progress.

Table 11: Mean±SE values of radiographic evaluation, pain on palpation, joint motion, weight bearing during standing and lameness during walk of group 1.

Days	RE	PP	JM	WBS	LW
0 (Before treatment)	2.33 ^a ±0.21	1.33 ^a ±0.21	1.83 ^a ±0.30	1.33 ^a ±0.33	1.67 ^a ±0.21
28 (After treatment)	1.50 ^b ±0.22	0.33 ^b ±0.21	0.67 ^b ±0.21	0.33 ^b ±0.21	0.67 ^b ±0.21

^aSuperscripts (a, b) represents within group at $p < 0.05$

Statistical analysis showed that Group 1 had significant improvement in RE, PP, JM, WBS, and LW scores, indicating the effectiveness of pentosan polysulfate, carprofen, and chondroprotective agents in managing hip osteoarthritis. The therapeutic benefits are likely due to the chondroprotective and disease-modifying actions of pentosan. These findings align with reports by Akaraphutiporn *et al.* (2020) [1], Smith *et al.* (2022) [17], and Mosley (2022) [10].

Clinical Parameter of Group 2

Dogs were evaluated for radiographic changes, pain on palpation, joint motion, weight bearing, and lameness using a 0-3 grading scale (McCarthy *et al.*, 2007) [8] on day 0 and day 28. Mean±SE scores at presentation were 2.33±0.42 (RE), 1.83±0.48 (PP), 2.00±0.52 (JM), 1.83±0.48 (WBS), and 2.17±0.30 (LW). By day 28, these improved to 1.50±0.22, 0.33±0.21, 0.67±0.21, 0.33±0.21, and 0.67±0.21, respectively, reflecting significant clinical improvement.

Table 12: Mean±SE values of radiographic evaluation, pain on palpation, joint motion, weight bearing during standing and lameness during walk of group 2.

Days	RE	PP	JM	WBS	LW
0 (Before treatment)	2.33±0.42	1.83 ^a ±0.48	2.00 ^a ±0.52	1.83 ^a ±0.48	2.17 ^a ±0.30
28 (After treatment)	2.33±0.42	0.33 ^b ±0.21	0.67 ^b ±0.21	0.67 ^b ±0.21	0.67 ^b ±0.21

^aSuperscripts (a, b) represents within group at $p < 0.05$

Statistical analysis revealed that Group 2 showed significant improvement in pain on palpation, joint motion, weight bearing, and lameness, confirming the effectiveness of physiotherapy for managing hip osteoarthritis. However, physiotherapy alone did not influence radiographic findings. These results align with Pankaj (2022) [13], who reported clinical improvement but no radiographic changes in musculoskeletal cases treated with modalities such as PEMF, LLLT, TU, TENS, PROM, and hydrotherapy. The benefits observed may be due to physiotherapy's ability to reduce pain, enhance circulation, decrease muscle tightness, stimulate the nervous system, and promote faster functional recovery (Rivière, 2007) [16].

4.3 Clinical Parameter of Group 3

Dogs in Group 3 were evaluated for radiographic changes, pain on palpation, joint motion, weight bearing, and lameness on day 0 and day 28. Mean±SE scores at presentation were 2.50±0.33 (RE), 2.60±0.22 (PP), 2.67±0.30 (JM), 2.80±0.17 (WBS), and 2.13±0.17 (LW), which improved to 1.17±0.30, 0.00±0.00, 0.17±0.17, 0.00±0.00, and 0.33±0.21 by day 28.

Table 13: Mean±SE values of radiographic evaluation, pain on palpation, joint motion, weight bearing during standing and lameness during walk of group 3.

Days	RE	PP	JM	WBS	LW
0 (Before treatment)	2.50 ^a ±0.33	2.60 ^a ±0.22	2.67 ^a ±0.30	2.80 ^a ±0.17	2.13 ^a ±0.17
28 (After treatment)	1.17 ^b ±0.30	0.00 ^b ±0.00	0.17 ^b ±0.17	0.00 ^b ±0.00	0.33 ^b ±0.21

*Superscripts (a, b) represents within group at $p < 0.05$

Statistical analysis confirmed significant improvement across all parameters, indicating that pentosan polysulfate combined with physiotherapy is highly effective for managing hip osteoarthritis. The strong therapeutic impact may be due to PPS's anti-inflammatory and chondroprotective actions, supported by findings from Kumagai *et al.* (2010) [7], Suheb *et al.* (2015) [18], and Akaraphutiporn *et al.* (2020) [11]. Physiotherapy further contributed to pain reduction, improved circulation, decreased muscle tension, nervous system stimulation, and faster recovery, consistent with observations by Pankaj (2022) [13].

Clinical Parameter of Group 4

Dogs in Group 4 were assessed for radiographic changes, pain on palpation, joint motion, weight bearing, and lameness using a 0-3 scale on day 0 and day 28. Mean±SE scores at presentation were 2.83±0.17 (RE), 2.67±0.21 (PP), 2.50±0.22 (JM), 2.67±0.21 (WBS), and 2.83±0.17 (LW). By day 28, these improved to 1.17±0.30, 0.00±0.00, 0.17±0.17, 0.00±0.00, and 0.33±0.21, respectively, showing marked recovery following femoral head and neck ostectomy with postoperative physiotherapy.

Table 14: Mean±SE values of radiographic evaluation, pain on palpation, joint motion, weight bearing during standing and lameness during walk of group 4.

Days	RE	PP	JM	WBS	LW
0 (Before treatment)	2.83 ^a ±0.17	2.67 ^a ±0.21	2.50 ^a ±0.22	2.67 ^a ±0.21	2.83 ^a ±0.17
28 (After treatment)	0.00 ^b ±0.00	0.00 ^b ±0.00	0.17 ^b ±0.00	0.50 ^b ±0.22	1.33 ^b ±0.21

*Superscripts (a, b) represents within group at $p < 0.05$

Statistical analysis showed significant improvement in RE, PP, JM, WBS, and LW scores in Group 4, indicating that femoral head and neck ostectomy followed by postoperative physiotherapy is effective for managing hip osteoarthritis. Postoperative VD radiographs revealed a clear gap between the proximal femur and acetabulum with no bony proliferation, consistent with findings from Off and Matis (2010), Nagaraju (2016), and Rahul (2023) [12, 11, 15].

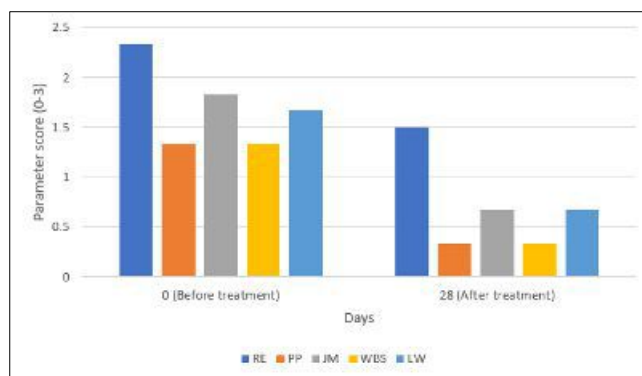


Fig 2: Mean±SE values of radiographic evaluation, pain on palpation, joint motion, weight bearing during standing and lameness during walk before and after treatment for group 1.

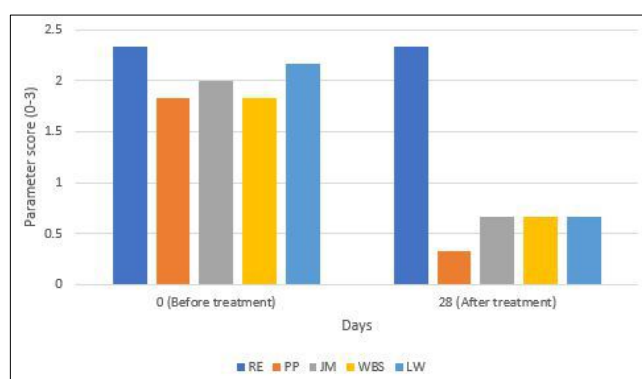


Fig 3: Mean±SE values of radiographic evaluation, pain on palpation, joint motion, weight bearing during standing and lameness during walk before and after treatment for group 2.

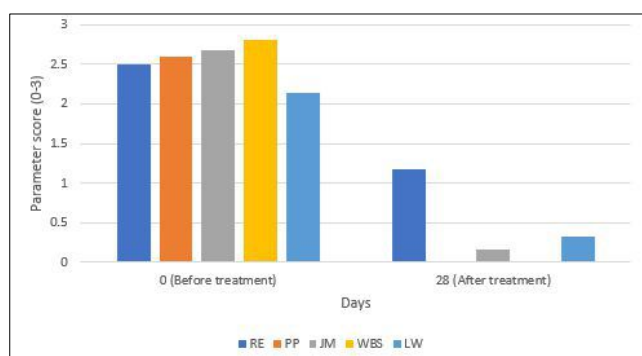


Fig 4: Mean±SE values of radiographic evaluation, pain on palpation, joint motion, weight bearing during standing and lameness during walk before and after treatment for group 3.

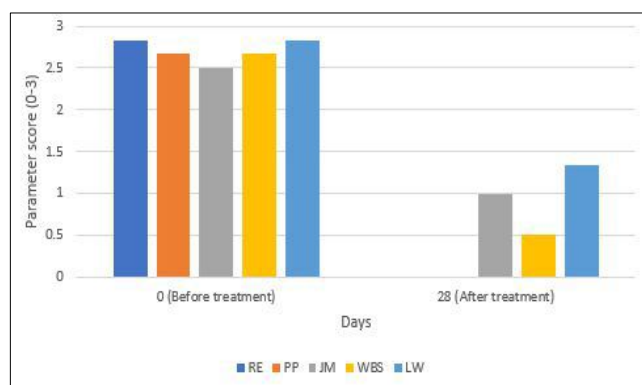
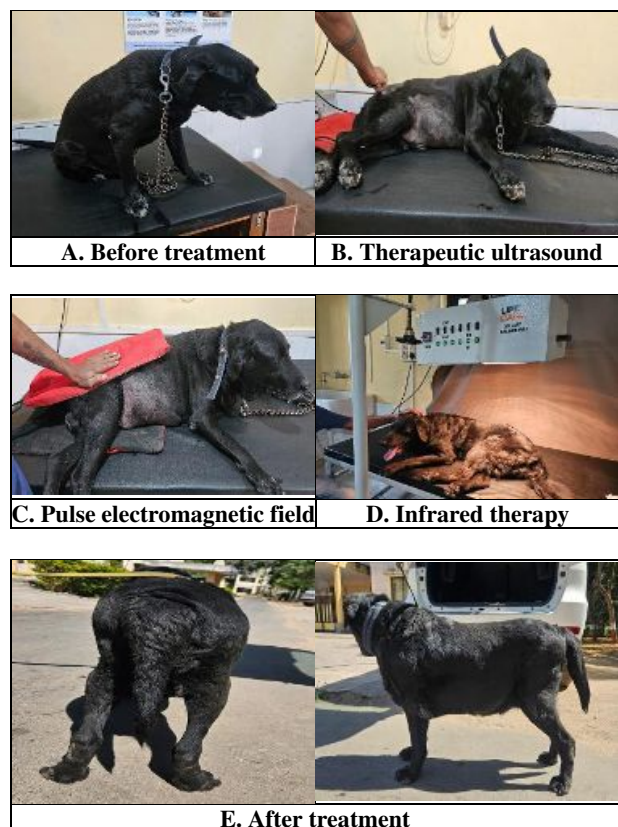
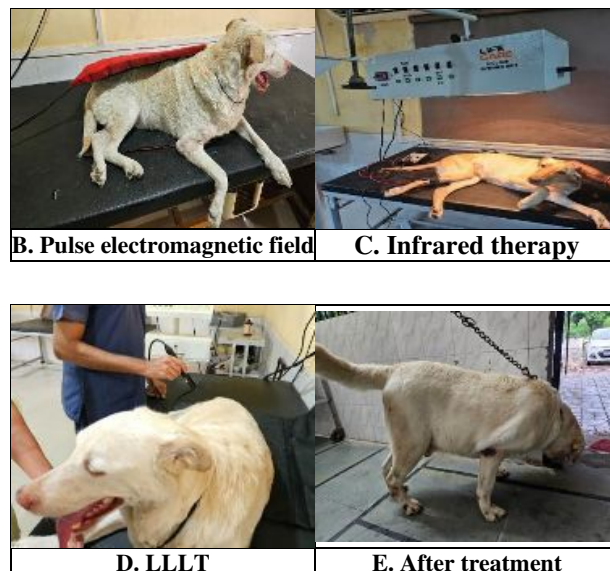


Fig 5: Mean±SE values of radiographic evaluation, pain on palpation, joint motion, weight bearing during standing and lameness during walk before and after treatment for group 4.

**Fig 6:** Group 1 Case before and after treatment**Fig 7:** Group 2 Case before and after treatment**Fig 8:** Group 3 Case before and after treatment**Fig 9:** Group 4 case before and after treatment

Conclusions

1. Dog suffering from hip OA shows clinical sign such as pain, reluctance to rise, crouching of back, stiffness, lameness, decrease joint space, osteophyte formation, and sclerosis of subchondral bone.
2. In this study, the combination of medicinal therapy and physiotherapy produced the greatest improvement in radiographic scores, pain, joint motion, weight bearing, and lameness, followed by the surgical group, medicinal-only group, and physiotherapy-only group. The superior outcome of the combined group reflects the therapeutic benefits of pentosan polysulfate and oral nutraceuticals, further enhanced by physiotherapy. Pentosan polysulfate administered S/C at 3.3 mg/kg weekly for four weeks was well tolerated, caused no adverse effects, and significantly improved clinical signs and quality of life in dogs with hip osteoarthritis.

3. Dogs undergoing femoral head and neck ostectomy followed by postoperative physiotherapy showed satisfactory recovery, regained functional limb use, and achieved high owner satisfaction. The study indicates that FHO is a simple, reliable salvage procedure for managing chronic hip osteoarthritis in dogs weighing 25-30 kg.
4. In medicinal management group with pentosan polysulfate sodium, oral nutraceuticals and Tab. Carprofen shows effective results for the management of hip OA.
5. In this study, physiotherapy alone produced good recovery in all dogs, demonstrating its effectiveness in reducing pain, improving mobility, and enhancing quality of life in hip osteoarthritis. While beneficial on its own, physiotherapy is most effective when combined with conventional treatments, as it accelerates overall recovery.

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