CLINICAL AND PHYSICAL EVALUATION OF INFRARED AND ULTRAVIOLET TREATMENT IN ARTHRITIC BUFFALO CALVES

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ABSTRACT

Acute traumatic arthritis of the radiocarpal joint was induced by injecting turpentine oil intra-articularly in 12 male calves divided into 3 equal groups. The arthritic animals of different groups were treated from 3rd day onward to 14th day by conventional therapy (Meloxicam inj. + Gentamicin inj.) along with infrared rays (Group T_1) and ultraviolet rays (Group T_2). Group T_3 served as treated control which included conventional therapy only.

Animals following induction of arthritis leads to recumbency, anorexia, dehydration, elevated rectal temperature as well as increased heart rate and respiration rate. Following application of various treatment these symptoms disappears almost in all groups. Recovery from pain after treatments was observed better in Group T_1 where almost 3/4th of the animals of these groups had no sign of pain on palpation on day 14. A progressive improvement in flexion response towards normalcy was observed on 14th day in Group T_1 followed by T_2 and T_3. In Group T_2 and T_3, the mean joint circumference remained significantly increased as compared to the base value till the end of observation period as compared to other treated groups. It is concluded that animals of Group T_1 treated with infrared rays exhibited faster relieve of pain, high reduction in joint circumference, better weight bearing, better flexion (reduction in stiffness) as compared to T_2 (Ultraviolet) and T_3 (conventional therapy). Hence infrared rays could be considered as better therapeutic modalities over ultraviolet rays.

Keywords: *Bubalus bubalis*, buffaloes, arthritis, buffalo calves, infrared rays, physiotherapy, ultraviolet rays

INTRODUCTION

Arthritis is the most common condition of domestic animals which considered as major cause of lameness. It causes joint pain, stiffness, immobility and swelling. Limb lesions accounted for 16.8%, where trauma was the main cause (Mclennan, 2008). Arthritis usually affects the bones and the joints; however, it can affect other parts of the body, such as muscles, ligaments, tendons, and some internal organs. Among different types of arthritis reported, traumatic and septic types are more severe affecting the animal and are the major causes of cripping-limb disease in animals. Lameness results in economic

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losses and welfare consideration (Shearer *et al*., 2013). Traumatic arthritis is a generalized term for changes to a joint resulting from either a single or repetitive trauma to that joint. Acute trauma to a joint may manifest as sudden onset of lameness with swelling, hotness and pain and distress (Shearer *et al*., 2013), which warrants early veterinary attention. Physiotherapy has been used in osteoarthritis by various workers in human patients (Page *et al*., 2011; Crossley *et al*., 2008). Physical therapy can be adopted if non surgical treatment doesn't provide relief to the patient. The goal of physical therapy and rehabilitation is to return the affected part and the animal to full function. There are many studies undertaken in man demonstrating the value of physiotherapy on early recovery, resumption of flexion, maintenance of productive life. There is lack of information about the use of intrared and ultraviolet ray for the management of knee arthritis in buffalo calves. Hence, the present paper described the physical and clinical changes following alterations after physical therapy.

MATERIALS AND METHODS

In all the animals, the carpal joints (knee joint) of either side were prepared aseptically. After 2 to 3 washing, about 1 ml of lignocaine hydrochloride (2%) was injected subcutaneously in the depression felt over the intercarpal joint at dorsomedial aspect of the carpal joint. The intercarpal joint was then entered with disposable 2.5 cm long 20 G needle in the depression medial to extensor carpi radialis tendon. About 1.5 ml of synovial fluid was aspirated and then 0.5 ml of turpentine oil mixed with 1 ml of Gentamicin was injected into the joint to induce acute traumatic arthritis.

The calves were randomly allotted into three groups of four animals each and the following treatment schedule was followed after 72 h of arthritis inoculation in different groups. All the animals were irradiated with infrared rays in Group T_1 and Ultraviolet rays in Group T_2 from 3rd day onward till 14th day. However conventional therapy comprising anti-inflammatory (Meloxicam 1 mg / 4 kg bwt.) and antibiotic (gentamicin 5 mg/kg bwt.) were given intramuscularly daily for ten consecutive days in all the groups including group T_3 which act as control.

The part to be irradiated with infrared rays was kept 30 to 35 cm away from the source in such a way that the rays struck at an angle of 90 degree. The time of treatment was 5 minutes for the first 3 days followed by 10 minutes for the remaining scheduled days.

The source of ultraviolet rays was positioned in such a way so as to strike the body part at an angle of 90 degree at a distance of 20 to 30 cm. The time of treatment was 5 minutes for the first 3 days followed by 10 minutes for the remaining scheduled days.

Physiological parameters like rectal temperature, heart rate and respiration rate were recorded on day 0, 3, 5, 7, 10 and 14. Physical examination of joint was conducted on day 0, 3, 5, 7, 10 and14.

Degree of lameness and weight bearing

Degree of lameness and weight bearing was assessed while the animal was in motion and graded as: Nil: Normal weight bearing (standing and progression), + (Mild): Normal weight bearing and slight limping, ++ (Moderate): Partial weight bearing and severe limping, +++ (severe): No weight bearing (touching the toe while standing and progression).

Pain on palpation

Pain on palpation was graded as: Nil :

No Pain, + (Mild): Bellowing and lifting the limb on extensive manipulation, ++ (Moderate): Protrusion of tongue and lifting of limb on palpation and little pressure, +++ (severe): Showing signs of apprehension when forced into walking.

Flexion response

Flexion response was graded as: Nil:

Normal Flexion, + (Mild): Flexion with some resistance / reluctance, ++ (Moderate): Flexion with great difficulty and pain, +++ (No Flexion): Animal not permitting any flexion.

Changes in joint circumference

Joint circumference of knee was recorded in each animal for the extent of local swelling at three places and the mean was calculated before induction and after induction on day 3, 5, 7, 10 and 14 as per method of Van Pelt (1983).

Statistical analysis

The data were statistically analyzed by one way analysis of variance (ANOVA) and Duncan Multiple Range Test (DMRT) as per method described by Snedecor and Cochran (2004). Level of significance was set at $P<0.05$.

RESULTS

The clinical signs manifested in the animals following induction of arthritis included recumbency, anorexia, dehydration, elevated rectal temperature as well as increased heart rate and respiration rate.

The rectal temperature exhibited a significant rise ($P<0.05$) up to 7th day of observation in Group T_1 and T_2 as compared to their base value. It was interesting to note that the maximum increase in temperature could be recorded on day 3 of observation in all the groups. After showing a significant hike, the rectal temperature in Group T_1, T_2, started declining gradually on subsequent days of observation and reached to almost base line value by 14th day of observation. In contrast to other treated groups, Group T_3 (control) showed a significant rise in temperature throughout the periods of observation (Table 1).

The maximum increase in heart rate could be recorded on 3rd day of observation in Group T_1, T_3 whereas it was maximum on day 5 in Group T_2 (Table 2). In Group T_3, the heart rate recorded on day 3 of observation differed significantly with that of values recorded on day 7, 10 and 14. The variation recorded on subsequent days of observation in different groups did not differ significantly among the groups.

The respiratory rate was significantly higher ($P<0.05$) in Group T_2 up to day 3 and 5 of treatment, respectively as compared to the value recorded on day 0. It was interesting to note that barring Group T_2, the other groups did not show any significant variation at corresponding intervals within groups. The increasing trend of respiratory rate up to day 3 declined gradually and reached to the base line value on day 14 of observation in all the groups (Table 3).

Degree of lameness and weight bearing

The result revealed that animals of all treatment groups suffered from severe lameness (graded as +++), had no weight bearing on affected limb and showed sign of apprehension when forced to walk on day 3 and 5. Recovery from lameness was noted from day 7 where 2/3rd animals of Group T_1 showed moderate lameness (graded as ++), had

Table 1. Mean ± SE values of rectal temperature (°F) at different intervals of treatments in arthritic buffalo calves.

Observation period (days)	Treatment groups		
	T_1	T_2	T_3
0	100.95 ± 0.6^{aBC}	100.85 ± 0.6^{aD}	99.95 ± 0.2^{aD}
3	103.18 ± 0.4^{aA}	104.05 ± 0.2^{aA}	103.15 ± 0.3^{aA}
5	102.58 ± 0.4^{aA}	103.40 ± 0.3^{aAB}	102.63 ± 0.3^{aAB}
7	103.13 ± 0.3^{aA}	102.25 ± 0.4^{aBC}	102.18 ± 0.3^{aB}
10	102.20 ± 0.3^{aAB}	101.83 ± 0.6^{aCD}	101.60 ± 0.4^{acBC}
14	100.33 ± 0.5^{bcC}	101.88 ± 0.6^{aCD}	100.90 ± 0.3^{acC}

Values bearing same superscript with small alphabets in a row and capital alphabets in a column did not differ significantly (P>0.05).

Table 2. Mean ± SE values of heart rate (beats/minute) at different intervals of treatments in arthritic buffalo calves.

Observation period (days)	Treatment groups		
	T_1	T_2	T_3
0	74.50 ± 2.10^{aB}	75.25 ± 2.29^{aB}	77.00 ± 2.97^{aAB}
3	89.75 ± 4.17^{aA}	92.50 ± 3.23^{aA}	85.00 ± 2.65^{acA}
5	87.50 ± 2.84^{aA}	92.75 ± 3.30^{aA}	79.00 ± 4.20^{aAB}
7	74.00 ± 1.68^{aB}	71.75 ± 1.18^{aB}	72.75 ± 2.75^{aB}
10	73.00 ± 1.47^{aB}	70.00 ± 1.83^{aB}	73.25 ± 1.11^{aB}
14	74.75 ± 3.54^{aB}	70.25 ± 1.75^{aB}	74.75 ± 1.18^{aB}

Values bearing same superscript with small alphabets in a row and capital alphabets in a column did not differ significantly (P>0.05).

Table 3. Mean ± SE values of respiration rate (breaths/minute) at different intervals of treatments in arthritic buffalo calves.

Observation period (days)	Treatment groups		
	T_1	T_2	T_3
0	23.0 ± 1.29^{aA}	21.0 ± 1.29^{aC}	22.5 ± 0.29^{aA}
3	25.2 ± 0.48^{bcA}	28.0 ± 0.91^{acA}	26.8 ± 0.48^{bcA}
5	22.2 ± 0.85^{aA}	25.0 ± 0.91^{aAB}	24.0 ± 1.47^{aA}
7	24.7 ± 0.85^{aA}	23.2 ± 0.48^{aBC}	25.0 ± 1.68^{aA}
10	23.7 ± 0.85^{aA}	20.7 ± 1.11^{aC}	23.5 ± 0.50^{aA}
14	22.0 ± 1.08^{aA}	23.0 ± 1.29^{aBC}	24.8 ± 0.25^{aA}

Values bearing same superscript with small alphabets in a row and capital alphabets in a column did not differ significantly (P>0.05).

Table 4. Mean ± SE values for changes in joint circumference (cm) at different intervals of treatments in arthritic buffalo calves.

Observation period (days)	Treatment groups		
	T_1	T_2	T_3
0	22.75 ± 0.77^{aB}	20.83 ± 0.33^{aB}	22.33 ± 1.09^{aB}
3	28.33 ± 0.48^{aA}	25.50 ± 0.41^{bA}	26.17 ± 0.17^{bA}
5	28.83 ± 0.22^{aA}	24.75 ± 0.57^{bA}	25.63 ± 0.28^{bA}
7	26.71 ± 0.46^{aD}	24.25 ± 0.32^{bA}	24.82 ± 0.47^{bA}
10	24.67 ± 0.56^{aC}	23.37 ± 0.38^{aC}	24.73 ± 0.51^{aA}
14	24.12 ± 0.41^{bcBC}	22.46 ± 0.46^{aC}	24.69 ± 0.53^{cA}

Values bearing same superscript with small alphabets in a row and capital alphabets in a column did not differ significantly (P>0.05).

partial weight bearing as compared to 3/4th animals of Group T_2. The animals of Group T_2 showed sign of improvement from day 10 in contrary to Group T_5, where none of the animals recovered completely from lameness. Animals of T_1 Group showed better results of treatment and almost 3/4th animals had no apparent sign of lameness. Animals of Group T_2 also showed better results of treatment in which lameness was apparently absent in 50% animals and rest of the animals had only mild sign of lameness.

Pain on palpation

Following acute traumatic arthritis, animals in various treated groups showed severe pain response till day 5 in physiotherapy aided treatment groups and till day 7 in Group T_5. Recovery from pain after treatments was observed from day 7 in Group T_1, T_2, and almost 3/4th of the animals of Group T_1, had no sign of pain on palpation on day 14. Whereas T_3 treated groups showed no sign of pain in 50% animals after 14th day of observation.

Flexion response

The flexion response was found to be poor till day 5 in the animals of all treated groups. A slight improvement in flexion response was recorded after 7 days of treatment in Group T_1 and T_2 whereas, the animals of Group T_3 did not show any improvement in flexion response. A progressive improvement in flexion response towards normalcy was observed on 14th day in Group $T_{1.}$ However, the animals of Group T_2 and T_3 showed poor flexion even after 14th day of observation.

Changes in joint circumference

The mean joint circumference in Group T_1 up to day 10, T_2 up to day 14 of treatment varied significantly ($P<0.05$) with their respective base line value. It was worthy to note that in Group T_2 and T_5, the mean joint circumference remained significantly increased as compared to the base value till the end of observation period. However, a declining trend could be observed conspicuously. The average joint circumference in Group T_3 remained significantly elevated ($P<0.05$) as compared to the preinjection value up to the end of observation period (Table 4).

The joint circumference in the animals of Group T_2 and T_3 differed significantly with that of Group T_1 on day 5 and 7 of observation among the groups. The maximum girth of joint circumference (28.83±0.22) could be recorded on day 5 post treatment in Group $T_{1.}$

DISCUSSION

Traumatic and inflammatory conditions of bursae, bones and joints in the acute stage are painful and results in exuberant callus formation and fibrous ankylosis. Intra-articular injury (injuries occurring within a joint) with cartilage damage can lead to traumatic arthritis, a condition characterized by pain and stiffness in the affected joint. Intra-articular injuries are often the result of high-energy injuries such as traffic accidents or bad falls.

Physiotherapy can be effectively used for treating the diseases of musculo-skeletal systems and integumentary systems. Heat increases the tissue temperature which leads to sedation and analgesia. Heat produces vasodilatation and promotes phagocytosis, helps in the healing process. Heat enhances metabolism and lymph flow, increases permeability of blood vessels leading to tissue oedema and increased absorption of toxins. Preheating connective tissue before it is stretched produces a greater residual increase in tissue length with less potential damage. Heating of the deep tissues alters the elastic properties of collagen tissue and its molecular bonding. Deep hyperemia caused by physiotherapy results in increased arterial flow with more oxygen and improved nutrition while the greater venous flow carries away larger degree the products of local metabolism. It promotes disintegration of inflammatory exudates and assists in their resort form by decreasing the swelling, relief of pain and restoration of the function clinically. The pain and spasm relieving effect of deep hyperaemia makes its use indicated in irritation of sensory and motor nerves.

In the present study, the clinical signs manifested in the animals following induction of arthritis included recumbency, anorexia and dehydration. Skeletal system is essential in promoting normal health condition among animals. When one of these bones or associated structures is damaged, normal activity will be severely hindered and thus animal remain in recumbency. Increase in the physiological parameters at initial stage of observation might be due to acute trauma to joint during experimental induced arthritis and associated structures resulted in inflammation, swelling, onset of lameness and stress (Chouhan, 1985). Reduction in lameness and pain after treatment may be ascribed due to heating effect of therapeutic modalities which results in vasodilation at joint. Vasodilation accelerate the removal of waste product and improve oxygen supply to damaged cells and help in resolution of inflammation. The electrical stimulation might be responsible for sympathetic contraction (Bromiley, 1991). Further the increase in heart rate might be due to increase in blood flow and muscle contraction after treatment. Higher respiration rate could be due to injury and pain induced activation of the sympathetic system (Morton and Griffith, 1985). This is also supported by the fact that the increase in blood supply and muscle contraction boost up the activity of respiration centre of hypothalamus and thus responsible for increase in respiration rate after treatment. Gudarjee *et al*. (2015) also reported significant increase in temperature and heart rate in the animal affected with arthritis in calves. Heating fibrous tissue structures such as joint capsules, ligaments, tendon and scar tissue may cause a temporary increase in their extensibility and hence a decrease in joint stiffness (Lehmann *et al*., 1970). Beside the viscosity of tissue will be reduced, which partly accounts for the reduction of joint stiffness that occurs with heating (Wright and Johns, 1961). A better joint flexion and range of motion could be observed in Groups T_1 by the end of observation period. It seems that heating nature of infrared and short wave diathermy induces muscular relaxation and thus helps in relieving muscle spasm associated with inflammation and trauma. Ultraviolet (Group T_2) was useful in relieving muscle spasm in early stage of treatment, but at later stage it causes stiffness of joint which might be due to bony changes as a result of irradiation. In Group T_3, improvement in flexion responses occurred only due to resolution of swelling.

The animal felt less pain and stiffness and had better function with respect to locomotion and weight bearing. These findings are inagreement with other studies in which physiotherapeutic modalities has been used for analgesia and improve in function (Deyle *et al*., 2005; Weng *et al*., 2009). The resolution of pain and reduction of stiffness in the present study might be attributable to the stimulation of muscular and periarticular connective tissue after treatment with physiotherapeutic modalities (Deyle *et al.*, 2000). O'Really *et al.* (1999) also reported gain in muscle strength which related with knee function. This is also a fact that explain the performance in weight bearing while walking and was progressively better following treatment.

Pain relief with infrared has also been described for treatment of knee arthritis (Gur *et al.*, 2003), reduction in lower back pain (Gale *et al.*, 2006) and increase blood flow over the treatment area (Ise *et al.*, 1987; Kobu, 1999). Recently infrared rays treatment has been documented in wound healing (Horwitz *et al.*, 1999), increase endorphine level and bioactivation stimulator (Laakso *et al.*, 1994). Ultraviolet light resulted in significant improvement in the duration of morning stiffness, fatique, joint stiffness, joint swelling and grip strength in human patients affected with rheumatic arthritis following treatment with physiotherapy. Oshima *et al.* (2011) effectively treated the osteoarthritis in rabbit by Led light by preservation of articular surface and decreased level of inflammation.

It is concluded that animals of Group T_1 treated with infrared rays exhibited faster relieve of pain, high reduction in joint circumference, better weigh bearing, better flexion (reduction in stiffness) as compared to T_2 (Ultraviolet) and T_3 (conventional therapy). Hence infrared rays could be considered as better therapeutic modalities over ultraviolet rays.

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