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Clinical and Radiographic Evaluation of Distal Cannon Bone Physitis in Cattle

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Abstract: The present study was designed to describe the clinical and radiographic findings of distal cannon bone physitis in cattle and to evaluate the outcomes of conservative and surgical treatment of such affection. Nine cattle aged 6-18 months and of both sexes were included in this study on the basis of clinical and radiographic evidence of physitis at the level of distal cannon bone. Affected cattle were subjected for clinical index scores and radiographic scores evaluation pretreatment and along the treatment duration. All cattle were assigned for conservative treatment including stall rest and diet correction in conjunction with long-term combinations of parenteral antibiotics and a Nonsteroidal Anti-Inflammatory Drug (NSAID) administration. By the 8th week post-treatment, the summation of clinical index scores and radiographic paramters showed a significant improvement with successful response to this conservative regimen in 6 cattle while the other 3 cases showed signs of septic physitis which subsequently conducted for surgical curettage of the physeal lesions. All cases of septic physitis were completely recovered with successful outcomes by the 8th week post-treatment. In conclusion, surgical curettage can be a useful adjunct to conservative treatment of the distal cannon bone physitis which considerably enable the affected cattle to be returned to its intended use with minimal cost. Moreover, the clinical index scores and radiography provide a precise paradigm for diagnosis and monitoring the outcomes of cattle physitis.

Key words: Cannon bone, cattle, conservative, curettage, physitis

INTRODUCTION

Physitis is a clinical syndrome including inflammation of the physis or growth complex of young rapidly growing cattle. It affect mainly the physeal regions of the immature long bones in both fore and hindlimbs (Barneveld, 1994; Dutra *et al*., 1999). Distal cannon bones physis are more commonly affected clinically. Also, it can be either aseptic or septic (Dutra *et al*., 1999).

Physitis is a disease of young cattle and is mostly multifactorial including: feed pushing for rapid growth (Barneveld, 1994), direct trauma to the ossification centers, infection (Hewicker-Trautwein *et al*., 2002; Houlihan *et al*., 2007), nutritional imbalances (hypervitaminosis D and elevated calcium-phosphorus ratio) (Davies and Munro, 1999), housing on slatted floor and it may be iatrogenic (Blake *et al*., 1997).

Physitis presents a confusing picture with significant lameness and often moderate swelling and pain (Enting *et al*., 1997; Dutra *et al*., 1999). Techniques for identifying physitis include clinical examinations, synovial fluid analysis and radiography. Moreover, it is important to rule out other causes for lameness such as arthritis and claw affections (Sayegh *et al*., 2001; Fjeldaas *et al*., 2007).

Early diagnosis of physitis is essential to assess the severity of the inflammation and to determine treatment (Verschooten *et al*., 2000).

The prognosis for physitis depends upon the degree of inflammation and the amount of secondary damage that has occurred (Enting *et al*., 1997). Serious damage to a physis, especially from traumatic causes will result in closure of the physis and limb deformities (Fjeldaas *et al*., 2007).

Treatment of physitis consists primarily of addressing the primary cause, preventing secondary damage and facilitates functional use of the affected limb (Barneveld, 1994; Desrochers *et al*., 1995). This is normally accomplished with conservative treatment including: stall rest, NSAID, parenteral and intraarticular antibiotic administration after arthrocentesis and correct balance of Ca-P ratio in the diet (Desrochers *et al*., 1995; Riley and Farrow, 1998; Kettner *et al*., 2003; Neil *et al*., 2010). However, surgical curettage of physis is indicated for septic cases does not respond to antibiotic therapy within an appropriate time frame (Goodrich and Nixon, 2004; Neil *et al*., 2010). In bovine practice, there is a lack of reference data on physitis. Thus, the present study was designed to describe the clinical and radiographic

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findings of distal cannon bone physitis in cattle and to evaluate the conservative and surgical treatment of aseptic and septic forms of such affection.

MATERIALS AND METHODS

Animals: A total number of nine dairy and beef cattle (6-18 months of age) of both sexes (5 male and 4 female) and different breeds (4 Holstein-Friesian, 3 Cross and 2 Friesian) were studied. Cattle were admitted to Mansoura Veterinary Teaching Hospital, Faculty of Veterinary Medicine-Mansoura University, Egypt; from July 2012 to May 2015. Cattle were included in the study on the basis of clinical and radiographic evidence of physitis. Descreptive details of distal cannon physitis in all affected cattle were presented in Table 1.

Clinical index scores: Cattle were clinically evaluated at walk and rest for subjective assessment of the clinical signs of physitis. All of these parameters were recorded and scored as clinical index scores by one person to be evaluated and compared at 0 time before treatment and along the treatment duration (Table 2). The physitis site were assessed and graded for physeal swelling on a scale from 0-3 (0 = absence of physeal swelling, 1 = mild swelling, 2 = moderate swelling and 3 = severe swelling). Lameness was graded on a scale 0-3 (0 = no lameness; 3 = severe lameness). Pain was assessed by firm digital pressure for the distal cannon region with one thumb and fetlock flexion shown by limb retraction (mild, score 1), exaggerated shaking of the limb (Moderate, score 2) and/or non-weight bearing (Severe, score 3). While, discomfort was closely evaluated by daily recording alteration in normal activities, appetite of the affected cow and change in normal attitude and laying bouts.

Radiographic examinations: Radiographic evaluation of the distal cannon region was conducted using a 70 kVp, 2 mAs radiography unit (Samsung-dong, SY-31-100- P, Seoul, Korea) with a 70 cm focal film distance. Dorsopalmar/plantar and lateromedial standards radiographic views were obtained for the affected limb. All radiographs were subjectively interpreted in comparison to the contralateral limb radiographs at the different times of evaluation until complete healing (Table 3).

Treatment protocol

Conservative treatment: All affected cattle with physitis were initially assigned for conservative regimen including: long-term parenteral antibiotic combination of penicillin and dihydrostreptomycin (Pentomycin, UNIVET Ltd, Ireland) were given intramuscularly, 4 mL/100 kg/a week. Also, NSAID as flunixine meglumine (Flunidine-ARABCO, Egypt) was administered intravenously at a dose of 1.1 mg kg^{-1} twice daily for a week. The diet was corrected by adding vitamin D supplements (AD_3E, Candles Pharm, Egypt) and adjusting the Ca: P ratio to 1.5:1. While, treated cattle were kept in stall rest with soft bedding for 4 weeks. Cattle that not respond to this regimen and showed signs of septic physitis which confirmed by radiological examination were underwent joint lavage and intra-articular injection of gentamicin sulfate (Gentamycin 10%, UCCMA Co., Egypt) in 4.0 mg kg^{-1} repeated 2 days later to be ready for surgical intervention.

Surgical treatment: The three cattle underwent surgical curettage; feed was withheld for 12-18 h prior to surgery. Preoperative antibiotic, cefotaxim (Cefotax-EIPICO, Egypt) at a dose rate of 2 mg kg^{-1} and flunixine meglumine at 1.1 mg kg^{-1} were administered IV for each animal. Sedation was conducted via IV injection of xylazine HCl (Xylaject 2%-ADWIA Co., Egypt) at 0.1 mg kg^{-1}. Then, the limb was anaesthetized with Intravenous Regional Analgesia (IVRA) using 20 mL lidocaine HCl (Debocaine 2.5%-Al Debeiky Pharmaceutical Co., Egypt). The

Table 1: Descriptive data of 9 cattle with distal cannon bone physitis

Case No.	Breed	Sex	Age (months)	Physitis site
1	Holstein-Friesian	Male	15	Right forelimb
2	Friesian	Female	11	Left hindlimb
3	Cross	Male	14	Left hindlimb
4	Holstein-Friesian	Male	6	Left hindlimb
5	Cross	Female	18	Right hindlimb
6	Friesian	Male	9	Left forelimb
7	Holstein-Friesian	Female	13	Left hindlimb
8	Holstein-Friesian	Male	12	Right hindlimb
9	Cross	Female	16	Left forelimb

Table 2: The clinical index scores for subjective assessment of clinical parameters in 9 cattle with distal cannon bone physitis

Clinical index	Score and description
Physeal swelling	0 = Absent; 1 = Mild; 2 = Moderate; 3 = Severe
Lameness	0 = Normal, cattle stands and walks with a level back 1 = Mildly lame, cattle develops an arched back to stand and walk 2 = Moderately lame, arched back is evident short strided gait 3 = severely Lame, inability to bear weight on one or more feet
Pain	0 = Absent; 1 = Mild; 2 = Moderate; 3 = Severe
Discomfort	0 = Comfort; 1 = Discomfort

Table 3: The radiographic observation scores for subjective assessment of radiographic changes in 9 cattle with distal cannon bone physitis

Radiographic paramter	Score and description
Physitis extension	0 = Absent; 1 = Partial; 2 = Complete
Osteolysis degree	0 = Absent; 1 = Mild; 2 = Moderate; 3 = Severe
Callus reaction	0 = Absent; 1 = Good; 2 = Complete bridging; 3 = Remodeling and complete healing
Periosteal reaction	0 = Absent; 1 = Positive

anaesthetized animals were positioned in lateral recumbency with the affected limb uppermost extended. The distal cannon region of the limb was aseptically prepared for surgery. An Esmarch's bandage with a tourniquet was placed above the carpus/tarsus to minimize hemorrhage. The optimal site for surgical access was determined using 18 gauge needles as markers which could be felt to enter the septic portion of the physis under intraoperative radiographs. A 10 cm caudal skin incision was made at the site of physitis. The incision was continued down with a combination of blunt and sharp dissection as required to gain access to the bone surface. The physis was curetted using a Spratt curette with a 2-cup size, until all macroscopically abnormal tissue was removed. After debridement, the cavity in the physis was thoroughly flushed with saline solution containing 1 mg mL^{-1} penicillin G sodium (Aqua-pen, CID, Egypt). All incisions were closed with simple interrupted sutures using 2/0 polygalactin 910 suture (Vicryl, Ethicon INC, UK). Operation wound was drained and covered with sterile non-adherent medicated pads and the limb was fully extended and bandaged from the claw up to proximal to the carpus/tarsus. The drain was cleaned with sterile saline once daily until its removal 48 h after surgery. Then, a fiber glass cast applied with the limb for 2 weeks postoperative until removal of the skin suture. After cast removal, the clinical parameters were assessed and a new cast was applied for 4 weeks until the treated cattle bearing weight on the operated limb. The preoperative antibiotic and anti-inflammatory were continued for five successive days in addition to IM injection of 10 mL vitamin AD_3E (Devedry Med, Arabcomed, Egypt) for each animal. Then, a systemic course of treatment with Amoxicillin trihydrate (Trioxil, L.A, UNIVET Ltd, Ireland) at a dose of 10 mg/kg/IM, was started day by day for 2 weeks. The animals were allowed for light hand waking for 10 min daily during the treatment period. Cattle were confined in a stall rest for 4 weeks and monitored daily for changes of clinical signs. The clinical and radiographic presentation of physitis healing progress was recorded weekly and over 2 months after treatment using a standard protocol of clinical index and radiographic scoring system for subjective evaluation afterwards.

RESULTS AND DISCUSSION

Clinical index scores findings: According to Table 1, the hindlimbs (6 cattle) showed higher incidence of physitis than the forelimbs (3 cattle). The left distal cannon bone (n = 6) were more affected than the right ones (n = 3), particularly in the hind limb.

At the first time of evaluation, the clinical index scores of the conservatively treated cattle showed increased physeal swelling (score 2-3) with severe lameness (grade 4/5), pain (score 3) and discomfort (score 1). By the 8th week post conservative treatment, the summation of clinical index scores for the physeal swelling, lameness, pain and discomfort showed significant decrease (score 0) with successful response to this conservative regimen in 6 cattle. While, the other 3 cattle showed signs of septic physitis which subsequently conducted for surgical curettage of the physeal lesions.

Radiographic findings: The follow-up radiographs taken soon after conservative treatment demonstrated radiopaque thickening located in the distal cannon physis with partial physitis extension (score 1) and mild osteolysis degree (score 1) without any periosteal reaction (Score 0) (Fig. 1). However, at 8th weeks post conservative treatment, the radiographic scores of treated cattle showed significant decrease (score 0) in physitis extension and osteolysis degree compared to those 3 cattle which not respond to this regiemen and showed signs of septic physitis. Moreover, the callus reaction demonstrate complete healing and remodeling of the physitis site without any periosteal reaction.

The intial radiographs of the septic physitis cases revealed a large irregular radiolucent defect along the entire physis with physitis extension (score 2) and osteolysis degree (score 3). Also, there was evidence of periosteal reaction (score 1) with radiopaque thickening located in the distal cannon physis without radiographic changes in the other joints (Fig. 2). The soft tissues surrounding the distal cannon physis were moderately swollen. Intraoperative radiographs after surgical debridemnt showed a a large radiolucent defect at the site of physis without dislocation of both epiphyses (Fig. 3). Subsequent posttreatment radiographs showed a new osteophyte formation with good callus reaction (score 1) between the physis fragments. The 1 month posttreatment, revealed decreased physitis extension (score 1) and osteolysis degree (score 2) with complete bridging callus (score 2). Radiographs taken 2 months after surgical currettage revealed significant decrease in the physitis extension (score 1) and osteolysis degree (score 2) with evidence of remodeling of the physitis site with smooth margin and evident slight perosteal reaction (score 1) (Fig. 4). At that time, there was a near-normal functional recovery of the limb in the affected cattle.

Treatment outcomes: Out on 9 cattle treated conservatively, six cattle were recovered within 2 months.While, the other 3 cattle not respond to the treatment and showed signs of septic physitis. These

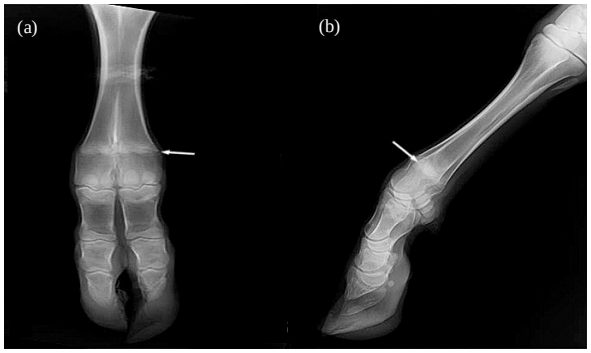

Fig. 1: a) Dorsopalmar and b) lateromedial, radiographic views of aseptic physitis of the distal cannon bone of the left forelimb in a Frisian cattle. Notice the radiopaque thickening located in the distal cannon physis (arrows) without any radiographic changes in the other joints

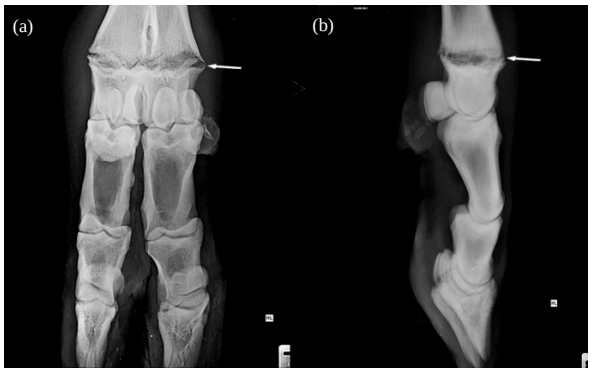

Fig. 2: a) Dorsoplantar and ateromedial, radiographic views of septic physitis of the distal cannon bone of the left hindlimb in a Holstein-Frisian cattle. Notice the large irregular radiolucent defect along the entire physis with irregular trabecular lucency and sclerosis of the surrounding bone (arrows)

cattle were treated surgically which showed significant recovery after 2 months post-surgical curettage without recurrence. All owners of the 9 surviving cows were contacted at least 4 months post-surgery and all reported a good functional outcome and cosmetic appearance.

Physitis is frequently occurs as a result of discordance in the longitudinal growth and maturation of physis, in concert with increasing body size, activity level and on stud farms where the Ca-P ratio is imbalanced (Davies and Munro, 1999; Houlihan *et al*., 2007). This suggests that, physitis cases in the present study are result of overloading of the physeal, weakened bone/cartilage, imbalanced ration or a combination of these factors.

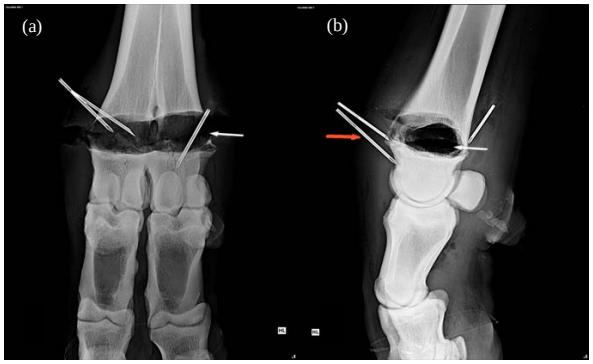

Fig. 3: a) Intraoperative dorsoplantar and lateromedial, radiographs of septic physitis case after surgical curettage of the physeal lesion. Notice the large radiolucent defect at the site of physis without dislocation of both epiphyses (white arrows). A 18 gauges needles were shown as a marker for location of physeal lesion (red arrow)

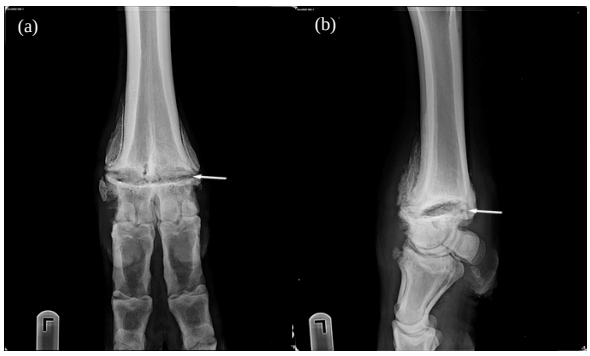

Fig. 4: a) Dorsoplantar and ateromedial, radiographs 2 months postoperatively. Notice the reduced physitis extension and osteolysis degree with remodeling of physis (arrows) with slight periosteal reaction

The distal cannon bone is the most active physis in the newborn cattle which can be subjected to physitis any time before the physis disappears radiographically (Verschooten *et al*., 2000). Thus, we aimed in this study to through the light on physitis cases in this physis region, for its clinical and economic importance in cattle.

Diagnosis and monitoring of physitis in cattle is not consistent. There is a high degree of variability associated with evaluation methods which cannot be easily compared (Verschooten *et al*., 2000). The system of evaluation (clinical index and radiographic scores) used in this study, permitted quantification of subtle clinical and radiographic features of the distal cannon physitis which could allow early recognition of physitis and produce more consistent results between cattle clinicians.

The clinical index scores provide a useful indicator of the physeal swelling, lameness, pain and discomfort of the affected cattle. The clinical improvement after successful treatment was represented by reduced physeal swelling and improved scores of lameness, pain and discomfort which manifested by normal weight-bearing without apparent lameness and pain in the treated cattle.

The degree of lameness associated with septic physitis may be variable, especially in the early stages of infection (Enting *et al*., 1997; White, 2002). Retrospectively, it likely reflected a progression in the severity of osteomyelitis. In this study, cattle with septic physitis showed initially moderate to severe lameness which turned into mild by healing progression after surgical curettage.

Clinical examinations alone may not be sufficiently sensitive for evaluation and monitoring of physitis progression. Radiographic evidence of physeal injury may be subtle early in the disease process. Sequential radiographic views of physitis have been recommended in cases treated medically and in postsurgical cases to confirm the lesion and monitor treatment outcomes (Verschooten *et al*., 2000). Thus, the collaboration system between the clinical index scores and radiography used in this study provides a proper simple tool for subjective assessment of effectiveness of conservative and surgical treatment of physitis in cattle.

Radiographic conformation of physitis is important to assess the severity of lesion and to determine the suitable option of treatment (Goodrich and Nixon 2004; Lawrence and Fraser, 2013). Therefore, a positive clinical progression (decreased swelling and lameness) and improved results of serial radiographic views represent more important indicators of early success in treatment.

Clinical and radiographic interpretation of the included cattle in this study, revealed a higher incidence of distal cannon physitis in the hindlimb (6 cattle) than in the forelimb (3 cattle), particularly the left ones (6 cattle). This could be attributed to greater exposure of the hindlimbs to a dirty environment, the size and weight of the udder may also make hindlimbs more susceptible to disorders (Alban, 1995). In addition, the forelimbs are able to compensate for traumatic overload in a better way because of their elastic tenomuscular attachment to the trunk (Cramer *et al*., 2008).

Treatment of physitis in cattle is challengeable. This could be attributed to the lack of published information regarding physitis in cattle practice (Barneveld, 1994; Kettner *et al*., 2003). Some reports suggest that the condition should be treated conservatively while others refer to surgical curettage as a viable option (Neil *et al*., 2010). Therefore, this study focused to be ideal representative for strategies applied in treatment of physitis in cattle.

Not all physitis lesions need to be treated surgically, conservative treatment as initial approach alone may be warranted in cases of aseptic physitis. Success with this approach will reduce patient morbidity and costs associated with surgical intervention (Desrochers *et al*., 1995; Lawrence and Fraser, 2013). In the present study, 6 cattle with aseptic physitis were successfully treated conservatively with parenteral antibiotic combination and NSAID with diet correction. Cattle with physitis that do not respond to conservative treatment should be monitored closely using serial radiographic examination. When early signs of osteolysis of the distal epiphysis are detected, surgical interference and stabilization of the bone should be considered to prevent further complications. The results of this study confirm that surgical curettage of septic physitis can be a useful adjunct to conservative treatment in severely lame animals.

The necrotic physeal tissue of septic physitis has minimal load-bearing capacity and it is much more important to remove the tissue in an effort to stop progression of the damage which may then lead to pathological fracture (Parviainen, 2003; Hall *et al*., 2012). Thus, the surgical curettage was our maneuver of choice to treat such cases guarding against progressive complications. To this end, early surgical intervention is warranted as clinical progression may be startlingly fast and apparently subtle lesions can become widespread in a few days.

In the present study, surgical curettage was performed in 3 cattle showed septic physitis without response to conservative treatment. Needle markers and radiographs were initially used for physitis localization in the distal cannon bone where muscle coverage was not an issue and the needle could be felt to drop into the infected area. With regards to the curettage, the demarcation between the necrotic tissue and normal physis was easily felt and surgeons can feel confident that reasonable force may be used without inadvertently causing significant iatrogenic damage.

The purpose of postoperative physis immobilization is to prevent pain associated with the instability created by surgical treatment and to allow bone and wound healing (Desrochers *et al*., 1995; Riley and Farrow, 1998). In our study, fiberglass cast was applied for 4 weeks postoperatively based on clinical and radiographic findings.

In most studies on treatments of physitis, healing of physitis cases specially septic ones were along

3-6 months (Barneveld, 1994; Dutra *et al*., 1999; Verschooten *et al*., 2000). The present study, indicated that the average duration of healing of aseptic physitis was 2 months while septic ones requires 2-4 months, this period was sufficient even when there were large defect in the distal cannon bones and when, there was discontinuity of the bone after curettage.

CONCLUSION

In conclusion, surgical curettage can be a useful adjunct to conservative treatment of physitis of the distal cannon bone which enables affected cattle to be returned to its intended use with minimal cost. Moreover, the clinical index scores and radiography provide a precise paradigm for diagnosis and monitoring the outcomes of cattle physitis.

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