

A post-mortem qualitative radiographic study of the foot with special reference to the digital lesions in culling lame cows

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Abstract: This cross-sectional and descriptive study was carried out on 43 samples of culled lame cows with digit disorders which were collected from slaughterhouse. After recording information for each cow, at least four radiographs were taken from amputated limb. New bone formation, osteolysis, soft tissue swelling and gas density were indices considered for assessing the severity of the disease. The prevalence rate of claw lesion among all cases was 69.7 per cent. Most lesions were mainly due to the effect of non-infectious lesions such as toe ulcer (3; 6.9 %), white line disease (5; 11.6 %), heel ulcer (6; 13.9 %), abaxial groove lesions (7; 16.2 %) and sole ulcers (9; 20.9 %), respectively. There were 20.5 % and 79.5 % cows with locomotion scores of 4 and 5, respectively. The most prominent radiographic abnormalities were noted in the P3 region of culling lame cows: widened vascular channels (23.2 %), extensor process enthesiophyte (62.7 %), flexor tuberosity enthesiophyte (65.1 %), osteolysis at the tip of the pedal bone (9.3 %), osteolysis of the plantar tuberosity (58.1 %) and abaxial wall (6.9 %), chip fracture (2.3 %), pathologic fracture (18.6 %), symmetric swelling (23.2 %), asymmetric swelling (69.7 %) and gas density into the claw (9.3 %). Septic arthritis and increase in joint width (18.6 %), bony ankylosis and subluxation (13.9 %) were noted in the Joints. In conclusion, radiography revealed the extent of osseous changes in cattle affected with laminitis, provided valuable additional information and confirmed the diagnosis and prognosis where a normal clinical examination seems inadequate.

Keyword: Claw, Cow, Deep Septic, Digit, Lameness, Radiology

1. Introduction

Lameness is considered to be a major welfare and economic problem of dairy. Economically, lameness due to lose in milk yield, weight and fertility and increases the risk of culling [1, 2, 3]. Next to mastitis and reproductive failure, lameness is an important cause of involuntary culling in dairy herds. Its annual incidence ranges between 4 and 55 cases per 100 cows per year [4]. Effect of lameness on culling is not clear-cut, because several authors have reported little or no increase in culling due to lameness [1, 5, 6]. The decision to cull a cow is complicated, with many factors influencing that decision, notably, age (parity), milk production, fertility, and health [7]. On the other hand, because of the low level of farmer's knowledge, training and

awareness, the risk of digital disease not being discovered until the clinical condition becomes very obvious. At that stage, the process responsible for the lameness is usually quite advanced and results in infection of bone and related tissue increases the risk of premature slaughter [3, 8, 9]. However, early and accurate diagnosis is vital in cases of bovine lameness. The chances of restoring the productivity of the animal, its milk yield or weight gain, depend largely on rapid medical or surgical treatment, the course of which relates directly to accurate diagnosis and appropriate treatment. In these instances, a radiographic assessment is often necessary and in most cases, useful to reach to a diagnosis [3, 10, 11, 12, 13, 14, 15].

The purpose of this study was to investigate and quantitate radiological findings in digital region of culled lame cows, with special reference to the lesions and their distribution.

2. Materials and Methods

This cross-sectional and descriptive study was carried out in the winter of the year 2009 at Meysam abattoir in the vicinity of Tehran (RobatKarim). Forty three culled lame cows of 1135 culled Holstein cows having digit disorders which were randomly selected for qualitative radiographical purpose. The owners were interviewed using a questionnaire to record pre-mortem information. All cases aged three to eight years; both front legs and hind legs were amputated at the carpal and the tarsal region, respectively, immediately after slaughter, examined and tabulated the type and distribution of foot lesions.

The digital region of amputated limb was cleaned thoroughly with water and a brushed before radiography to be able to exactly diagnose the kind of injury in the radiographic projections. The amputated limbs were admitted to the Radiology Section of Tehran University Veterinary Hospital for more routine radiographical studies. Four radiographs were taken from each case, in lateral-medial or medial-lateral, dorsopalmar/dorsoplantar, dorsolateral-palmaromedial / dorsolateral-plantaromedial and dorsomedial-palmarolateral / dorsomedial-plantaromedial. Radiographs were recorded by the mammography cassettes in sizes of 18×24 and 24×30, and the required exposure factors of 85-95 KV, 25 mA in 0/04-0/02 seconds (Toshiba, DC-12M, Japan). New bone formation, osteolysis, soft tissue swelling, and gas density were indices considered for assessing the severity of the disease. At the visits, the locomotion scores of all of the lame cows (n = 43) were recorded. The locomotion score was determined by two observers working together. Each

animal was observed standing and walking (on a concrete surface whenever possible) using the Sprecher scoring system [16]. Finally, the findings were discussed descriptively.

3. Results

Radiographic images taken from the involved digits of the forty three culled lame cows depicted a quite wide range of radiographic signs such as soft tissue swelling, new bone formation, osteolysis and gas density which were observed mostly in the hind limbs. All signs were relatively the same as forelimbs and the hind limbs. These signs were distributed in different sizes; they were more significant considering the increased infection and the involvement of other neighboring structures, such as coffin's joint, distal sesamoid bone and even the adjoining digit bones. Radiological examinations showed that chronic lesions of claw are accompanied by alterations in the structure of phalanges. In most of cases chronic osteophytes of extensor tendon was seen at insertion on the extensor process as well as calcification of the deep flexor tendon on PIII bone. Four out of the total of 43 cases showed osteolysis at the tip of the pedal bone (9.3 %). Twenty-one out of the total of 43 cases showed periosteal new bone formation on the volar process, extensor process and plantar tuberosity, and also these cases had osteolysis on the caudal part of the plantar tuberosity of P3 bone (48.8 %). Table 1 illustrates the radiographic changes in the distal phalanx. Complete fractures of metacarpal and metatarsal bone, however, were rare in this study but accounted for 2 out of 43 cases of lameness in culling lame cow.

Table 1: Bone and soft tissue alterations of the distal phalanx of forty three culled lame cows at the radiologic examination.

Type of lesions of P3	Fore limb		Hind limb		Total	
	No. of cases (%)		No. of cases (%)		No. of cases (%)	
Widened vascular channels	1 (2.3)		9 (20.9)		10 (23.2)	
Fracture	Sequestration (Pathologic)	2 (4.6)	6 (13.9)		8 (18.6)	
	Chip	-	1 (2.3)			
	Toe	1 (2.3)	3 (6.9)		4 (9.3)	
Pedal Osteolysis	Plantar tuberosity	3 (6.9)	22 (51.1)		25 (58.1)	
	Abaxial wall	-	3 (6.9)		3 (6.9)	
	Symmetric	2 (4.6)	8 (18.6)		10 (23.2)	
Type of digital Swelling	Asymmetric	6 (13.9)	24 (55.8)		30 (69.7)	
	No Swelling	1 (2.3)	2 (4.6)		3 (6.9)	
	Volar process	4 (9.3)	23 (53.4)		27 (62.7)	
Periosteal New Bone Formation	Extensor process	5 (11.6)	22 (51.1)		27 (62.7)	
	Plantar tuberosity	4 (9.3)	24 (55.8)		28 (65.1)	
Gas density into the claw	-		4 (9.3)		4 (9.3)	

Thirty one out of the total of 43 cases showed periosteal new bone formation on the P2 and P3 bones (72.0 %). Table 2 illustrates the radiographic changes in the proximal and middle phalanges.

Septic arthritis accounted for 8 out of the total of 43 cases

found (18.6 %). About 75.0 % of arthritis was observed in distal inter-phalangeal joint.

Fifteen out of the total of 43 cases showed periosteal new bone formation on the lateral and medial surface, and also these cases had osteolysis on the dorsal surface of sesamoid

bone (34.8 %). Table 3 illustrates the radiographic changes in the distal sesamoid bone.

Thirty cases were affected by lesions in different regions of claw capsule (69.7 %). Most lesions were mainly due to the effect of non-infectious lesions such as toe ulcer 3 (6.9 %), white line disease 5 (11.6 %), heel ulcer 6 (13.9 %), abaxial groove lesions 7 (16.2 %) and sole ulcers 9 (20.9 %), respectively. The prevalence rate of claw lesion in the hind limb was higher than fore limb. Lacerations, fracture,

penetrating injuries, interdigital lesion such as IDN, ID were other digital lesion in this study.

All cases showed signs of disability in weight bearing. Problems with weight bearing, arching of the backbone, lowering of the head and holding abducted of the affected limb were considered as the significant clinical features, in evaluation of locomotion scoring. Locomotion scoring assessment of 43 culled lame cows showed score ranged from grade 4 (20.5 %) to 5 (79.5 %) on a scale of 1 to 5.

Table 2: Bone and soft tissue alterations of the proximal and middle phalanx of forty three culled lame cows at the radiologic examination.

	Type of lesions of P1			Type of lesions of P2		
	Fore limb	Hind limb	Total	Fore limb	Hind limb	Total
	No. of cases (%)	No. of cases (%)	No. of cases (%)	No. of cases (%)	No. of cases (%)	No. of cases (%)
Osteolysis	1 (2.3)	3 (6.9)	4 (9.3)	2 (4.6)	12 (27.9)	14 (32.5)
Periosteal New Bone Formation	6 (13.9)	28 (65.1)	34 (79.0)	7 (16.2)	29 (67.4)	36 (83.7)
Fracture						
Sequestration (Pathologic)	-	-	-	-	6 (13.9)	6 (13.9)
Cheap	-	1 (2.3)	-	-	1 (2.3)	1 (2.3)
Gas density into the P1 and P2 region	2 (4.6)	2 (4.6)	4 (9.3)	1 (2.3)	8 (18.6)	9 (20.9)

Table 3: Radiographic changes in the sesamoid bone of forty three culled lame cows.

Type of lesions of sesamoid bone	Fore limb	Hind limb	Total
	No. of cases (%)	No. of cases (%)	No. of cases (%)
Pathologic Fracture	-	5 (11.6)	5 (11.6)
	Dorsal Surface	14 (32.5)	16 (37.2)
Osteolysis	Lateral Surface	-	1 (2.3)
	Medial Surface	-	1 (2.3)
	Dorsal Surface	-	-
Periosteal New Bone Formation	Lateral Surface	18 (41.8)	20 (46.5)
	Medial Surface	20 (46.5)	22 (51.1)
Gas density	-	3 (6.9)	3 (6.9)
Bony Ankylosis	-	5 (11.6)	5 (11.6)

4. Discussion

In this study, radiography has been limited to the digital region of culling lame cows. On radiographic examination, a considerable amount of new bone formation, osteolysis and gas density within the affected digit were observed. The best way of detailed differential diagnosis of these lesions is radiography. However, radiographic signs of foot infection should be interpreted in conjunction with other clinical information.

In radiographs, soft tissue swelling was a common sign for lame cows with digital lesions. Soft tissue swelling proximal to the hoof wall is a consistent finding in cattle with foot infections [2, 3, 11]. In our experience, all culled

lame cattle with asymmetrically swollen digit had deep sepsis of the digit. In cases with septic osteitis of the digital bone, the swelling was appeared focally in bulb heel of the involving digit which can be proper factors for the prognosis of the digital bone changes.

Periostitis commonly occurs in the phalanges, leading to exostosis. In the present study, this condition was seen mostly in the hind limbs. Calcifications of the deep flexor tendon as well as osteophytes of the common digital extensor tendon insertion on the third phalanx were the most commonly involved structures. It has been claimed that exostosis of the deep flexor tendon at its point of insertion, is seen at the point directly dorsal to many cases of ulceration of the sole [14]. But in this study calcifications of the deep

flexor tendon on the third phalanx were not related to sole ulcer, specifically. This finding agrees with those of other workers [17]. Greenough (1981) suggested that increase in size of the plantar process is a consequence of ageing, assumed to arise from traction by ligaments [18]. In the lame cows, excessive tension due to abnormal weight bearing and abnormal stance can also influence calcifications of the deep flexor tendon and the common digital extensor tendon on the third phalanx [3, 19]. Gantke *et al.* (1998) suggested that changes in shape of the extensor process, shape of the dorsal surface of P3 were judged as physiologic variations [20]. Zantiga (1973) observed that not all open lesions of the sole are associated with pedal bone change [15]; osteolysis or proliferative changes are secondary to an inflammatory reaction or develop progressively due to either persistence of external lesions or as result of aseptic or septic complications [12]. The findings are in contrast to the findings of Rusterholz (1920) who observed exostosis of the plantar process and at insertion of the flexor tendon in solar ulceration [14].

Maclean (1970) suggested that the presence of this lesion could be used as an aid to diagnose laminitis in barley-fed beef cattle [21]. Therefore, the prevalence of osteopathy in the P III bone of the culling lame cows is further evidence that laminitis occurred in this group of animal. Greenough (1990) suggested that osteopathy of the apex of the distal phalanx is related to intensive feeding which is consistent with the concept of ruminal acidosis induced laminitis [22].

In this study, post mortem examination revealed that typical changes of chronic laminitis were among the most common pathological features, suggesting that laminitis may have affected virtually all the herd at some previous time.

Pedal osteolysis was second in importance in dairy cows, and accounted for 32 out of 43 cases found (74.4 %). The most common lesion, osteolysis of plantar tuberosity was found in 22 animals (51.1 % of the total). In interpretation of pedal osteolysis, various radiographic changes were found on the toe, plantar tuberosity and abaxial wall of P3 bone; these signs are due to the persistence of the external lesion. When the corium is exposed, infection can invade the deeper structures of the claw and travel proximally to involve the claw structures, resulting in necrosis of the P III bone. Nuss *et al.* (1996) suggested that the osteolysis and pedal osteitis in the region of the laminae at the dorsal edge of P3 are considered signs of laminitis [23].

In cases with toe ulcer, two of them showed toe fracture and the enthesiophyte of the extensor process was 66.6 %. Osteolysis of the tip of P3 is common following septic traumatic pododermatitis at the pedal bone tip. Inexperience claw trimmers tend to over trim the horn sole and to grind off the sole wall edge excessively and an infection of the corium at the toe region leads to a direct involvement of the pedal bone rapidly due to the very thin layer of corium and digital cushion in this area [24]. It has been claimed that clinical signs of apical pedal bone necrosis varied widely depending on the severity of the lesions [24]. However, the

location of exposed lesion on the digital region is more important than severity of lesion. Since contact with ground surface can be an excessive painful condition and explain the severe stilted movements often seen in these animals.

In cases with white line disease, most of them showed solar margin bone absorption, flexor tuberosity enthesiophyte, extensor process enthesiophyte. One of them showed bone sequestration of P3 bone. Hashemi *et al.* (2005) studied the radiographic appearance of 20 cow digits, with signs of white line disease [25]. The most prominent radiographic abnormalities of the claw artery included perivascular sclerosis (100.0 %) and vascular dilations (90.0 %). Other important findings included extensor process enthesiophyte (80.0 %), solar margin irregularities (65.0 %), flexor tuberosity enthesiophyte (40.0 %), solar surface bone proliferation (40.0 %), dorsal wall bone proliferation and solar margin bone absorption (45.0 %).

In cases with heel ulcer, most of them showed extensor process enthesiophyte and osteolysis of the plantar tuberosity on the P3 bone.

In cases with abaxial groove lesions, most of them showed osteolysis of the abaxial wall margin. Flexor tuberosity enthesiophyte and extensor process enthesiophyte were seen. Two of them showed septic arthritis.

The high percentage (18.6 %) of bone sequestration is not surprising in culling lame cows. The formation of sequestrum is due to a loss of endosteal blood supply from thrombosis of branches of the nutrient artery [26]. The dead bone is separated and is surrounded by purulent material. Ultimately, fibrous tissue and new bone will be formed in the medullary canal with subperiosteal new bone covering the sequestrum. The sequestra slow healing and reparative process, allowing bacteria to persist. They may also be a source of reinfection [26].

On radiographic examination, markedly widened vascular channel on the dorsal surface were observed in about 23.2 % of cases. In chronic cases, the widened vascular channels were considered sign of laminitis, [3, 10, 21] whereas the other observations also were made in affected claw. Boosman (1990) studied the arteriographic appearance of bovine hind digits, with microscopic signs of chronic laminitis [27]. The most prominent arteriographic abnormalities of the digital artery include dilatation and a tortuous, irregular course. Maclean (1970) observed similar changes in laminitic fore-claws of barley beef animals. The vascular channels in the pedal bone were dilated [21].

Gas density, however, was rare in this study but accounted for 4 out of 43 cases in both P1 and P2 regions (9.3 %) and 9 for P2 region (20.9 %). The multiple foci of gas of variable size and shape indicate presence of an abscess in the swollen soft tissue [10]. The low percentage of gas density is not surprising, because the occurrence of abscess is common in acute case and not chronic case such as most culling lame cows in this study.

In conclusion, radiography revealed the extent of osseous

changes in cattle affected with laminitis, provided valuable additional information and confirmed the diagnosis and prognosis where a normal clinical examination seems inadequate.

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