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# Arteriographic Evaluation of Laminitis Digits in the Hind Limbs of Dairy Cattle

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## Abstract

**Objective:** Laminitis is one of the main causes of lameness in dairy cattle. In this situation the corium blood circulation is disrupted and the production of healthy horny hoof wall is reduced. The purpose of this study was to evaluate the arteriographic pattern of the digital arterial branches in the laminitic digits and to compare them with the normal digits.
**Design:** Original study.
**Animals:** Thirty eight laminitic and four normal hooves from hind limbs of the Holestein dairy cattle were collected from Shiraz slaughter house, Fars province, Iran.
**Procedure:** The dorsal digital artery of each limb was catheterized, followed by the injection of a 20 ml contrast media into each artery, in order to obtain appropriate radiographs from dorso-plantar and latero-medial positions. The arteriograms were studied and digital vascular alterations were recorded. The number of arteries, diameter of the arteries, the number of missing arteries, the number of extra arteries and angiogenesis were finally recorded.
**Results:** The overall vascular alterations were 52.6% and 47.3% in the lateral and medial hooves, respectively, which were not significantly different ($P>0.05$). Angiogenesis and new blood vessels were observed both in the lateral and medial hooves in 31.5% of the cases. No alteration in the vascular pattern of the heel area in the lateral arteriograms was observed compared to the healthy hooves. All the proven vascular changes from both lateral and medial digits of the hind limbs did not show any significant differences ($P>0.05$) implying that laminitis is a systemic disease and its effect is equally induced on the vascular pattern of both digits.
**Conclusion:** Lame cattle affected by laminitis develop vascular alterations in digits and need urgent care to reduce further complications.

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**Clinical Relevance:** Prevention of lameness in dairy cattle**.**
**Key words:** dairy cattle, lameness, laminitis, arteriography, hind digit**.**

## Introduction

One of the most important diseases in dairy cattle is lameness which induces great economic loss due to reduced milk production, cost of labor, and cost of treatment, post op maintenance and culling.[3,15,16] Laminitis is one of the main causes of lameness in dairy cattle. In this situations the corium blood circulation is disrupted and therefore the production of healthy horny hoof wall is reduced. [2,14] Laminitis is a multi factorial disease and is basically related to the age of cattle, parturition, parity, season, milk production, nutrition, animal behavior, management, bedding, hoof trimming protocol, and etc.[1,6] Laminitis is presented in acute, subclinical and chronic forms; the subclinical form is more important which more likely progress into the chronic form.[1,2] The pathogenesis study of the laminitis have indicated that the process of the disease involves the hoof vascular system, hoof connective tissue and suspensory apparatus or ligaments which involves the dermal attachments to the epiderm and finally their effects on the proliferation, differentiation and creatinization of the epidermal cells.[9,10] The main digital arteries include axial proper digital artery and abaxial proper digital artery. The abaxial proper digital artery is basically nourishes the heel area but the axial proper digital artery provides terminal arch of the hoof by three main branches to include the terminal branch, axial branch and abaxial branch which circulates the marginal area and sole of the digits.[5,11] During the laminitis process, either endotoxins or hormones (Epinephrine, norepinephrine) and inflammatory mediators induce digital arterial constriction and reduce the digital circulation, which in turn induce more adverse reaction that could be due to Disseminated Intravascular Coagulation (DIC), extension of digital vascular constriction and imbursements of high arterio venous direct shunts. These shunts would deviate more blood from dermal and epidermal layer circulations therefore induce more alteration in the digital hoof structures.[7,8] The purpose of this study was to evaluate the arteriographic pattern of the digital arterial branches in the laminitic digits and to compare them with the normal digits.

## Materials and Methods

Thirty eight laminitis and four normal hooves of hind limbs of the Holestein dairy cattle were collected freshly from the Shiraz slaughter house, Fars province, Iran. The specimens were cleaned and the dorsal digital artery of each limb was dissected and catheterized by a 16 gauge angiocatheter. The artery was flushed by heparinized saline, a 20 ml of contrast media (Iodinated ethylesters of fatty acids obtained from poppy seed oil- Lipidol® Ultra fluid 480mg/ml) was subsequently injected into the each artery and appropriate radiographs were obtained immediately in dorso-plantar and lateralo-medial positions. Exposure factors of 20 mAs, 65 KV and 70cm FFD were used. The arteriograms were interpreted properly and digital vascular alterations were recorded. These alterations were included: number of arteries, diameter of the arteries, the number of missing arteries, the number of extra arteries and angiogenesis. The results were analyzed by Anova and paired T test using SPSS soft ware for windows and $P<0.05$ was considered significant.

## Results

The healthy hoof arteriographic pattern was used to compare with vascular alterations of the chronic laminitis hooves (Fig.1). The percent of each branch of the proper digital artery missing completely or partially (Fig. 4 and 5) in the lateral or medial digits of the hind limb is presented in the table 1. The overall vascular alterations were 52.6% and 47.3% (table 1) in the lateral and medial hooves respectively, which were not significantly different (P>0.05). Angiogenesis and new blood vessels were observed both in the lateral and medial hooves in 31.5% of the cases (Fig. 2 and 3). No alteration in the vascular pattern of the heel area in the lateral angiograms was observed in compared to the healthy hooves.

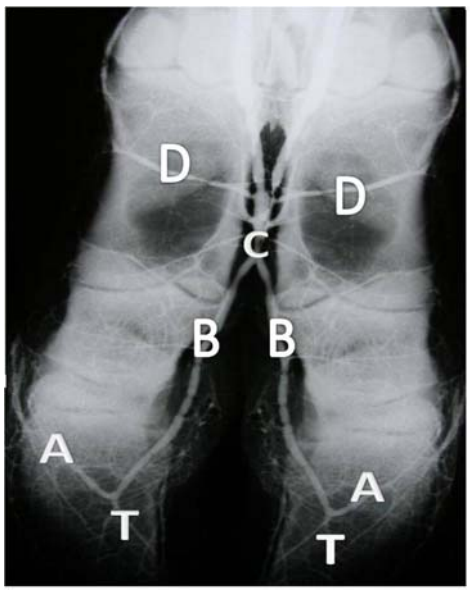


**Figure 1.** Arteriography of normal bovine hoof (Dorso-Plantar view). Distal arch (A), Axial (plantar) proper digital arteries III and IV (B). Plantar common digital artery (C). Abaxial pedal digital arteries III and IV (D). Terminal branch (T).

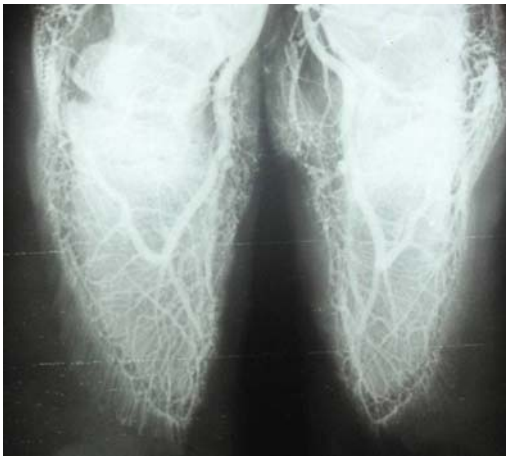

**Figure 2.** hypervascularity of both digits in a case of laminitis digit

**Table1.** The percent of missing arteries branched from proper digital artery picked up by digital arteriographic study in the hind limb of dairy cattle affected by laminitis.

| | No. of laminitic digits | Terminal branch (%) | Axial branch (%) | Abaxial branch (%) | Overall vascular alterations (%) |
|---|---|---|---|---|---|
| Lateral digits | 38 | 52.6 | 57.8 | 42.1 | 52.6 |
| Medial digits | 38 | 36.8 | 42.1 | 31.5 | 47.3 |

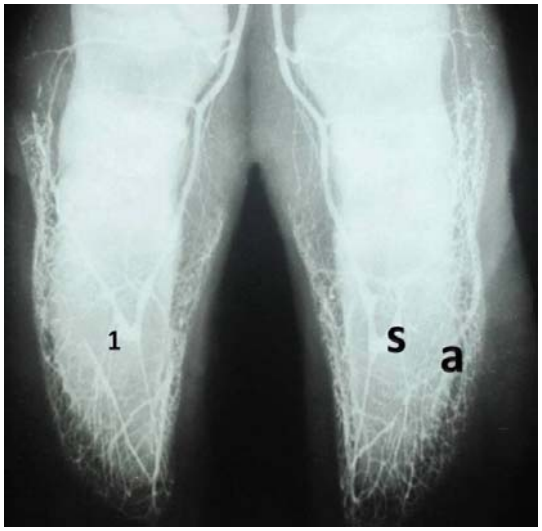


**Figure 3.** Extra new branch(1), hypervascularity of sole and white line area (a) and dilated solar artery(s).


**Figure 4.** Missing branches of (a), (b) and (c) in a case of laminitis.

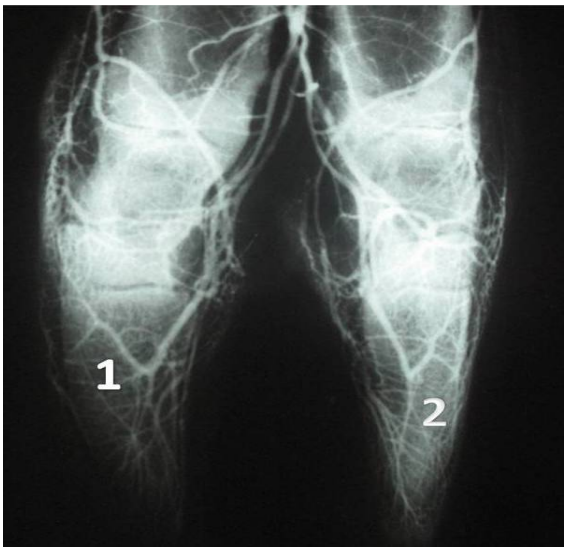


**Figure 5.** Missing branch (1), and (2) in a case of laminitis .

## Discussion

Boosman (1989) reported the correlation between the vascular alterations in the digits affected by laminitis along with the macroscopic changes.[4] Sing *et al* (1994) found that whenever there is sole ulcer, the proper digital artery either is severely constricted or is completely thrombosed.[12] Van Amstel (2006) also found similar changes in the advanced sole ulcer or overgrown hooves.[13] In this study, the terminal, axial and abaxial branches of the proper digital artery showed the most complications such as complete and partial thrombosis, angiogenesis, and vascular proliferations, which were reported more complications than that of the heel vascular system. The reason for this difference might be due to the fact that sole arteries emerge single from the proper digital artery and produce limited anastomosis to the

terminal arterial arch, but the heel arteries showed little alterations in laminitic hooves due to numerous anastomosis they make with the coronary and priopelic arteries. Therefore, they do not induce any vascular compromise. Following the thrombosis of the any branch of the proper digital artery, there would develop new branches (angiogenesis) and anastomosis of the arteries that could lead to disorganized and compromised highly vascular area observed in 50% of the laminitic hooves. These branches specifically were noticed along the terminal branches. All the vascular changes were picked up in the both lateral and medial digits of the hind limb showing no significant differences ($P>0.05$) proving that laminitis is a systemic disease and its effect is equally induced on the vascular pattern of both digits. Clinically, it has also been observed that similar laminitis lesions in similar anatomic locations presented on both lateral or both medial digits of hind limbs in laminitis conditions.

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## چکیده:

# ارزیابی آرتروگرافیک انگشتان مبتلا به لامینیت در اندام خلفی گاوهای شیری

**مصطفی نوربخش[1] ، سیف ا..دهقانی ناژوانی*[1] ، عبدالحمید میمندی پاریزی[1] ، مینا تجلی[2]**

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**هــدف**- لامینیت یکی از علل اصلی لنگش در گاوهای شیری است. در این صورت گردش خون بافت کوریوم مختل شده و تولید بافت شاخی سالم در دیواره سم تقلیل می‌یابد. هدف این مطالعه ارزیابی الگوی آرتریوگرافی شاخه‌های شریانی انگشتی در انگشتان مبتلا به لامینیت و مقایسه آنها با انگشتان سالم بوده است.

**نوع مطالعه**- مطالعه تحقیقی

**حیوانات**- تعداد ۳۸ پای مبتلا به لامینیت و ۴ پای سالم از گاوهای شیری نژاد هلشتاین از کشتارگاه شیراز برای این مطالعه تهیه گردید.

**روش کار**- شریان انگشتی پشتی هر پا جدا و سوندگذاری شد. مقدار ۲۰ میلی لیتر از محلول ید دار اتیل استر روغن دانه پاپایا با نام تجارتی لپیدول در هر شریان تزریق شد. برای تهیه تصاویر مناسب رادیوگرافها در حالت گماری پشتی خلفی و جانبی میانی تهیه شدند. فیلم‌ها مورد مطالعه قرار گرفتند و تغییرات عروقی در انگشتها شناسایی و ثبت شدند. تعداد شریانها، قطر آنها، تعداد شریانهای حذف شده، تعداد شریانهای اضافه شده و عروق زایی مورد توجه قرار گرفت.

**نتایج**- نتیجه کلی تغییرات نشان داد که در سم جانبی ۵۲/۶٪ و در سم میانی ۴۷/۳٪ تغییرات عروقی وجود داشت که از نظر آماری تفاوت معنی‌داری بین دو سم نبود ($P>0.05$). عروق‌زایی و عروق جدید هم در سم میانی و هم در سم جانبی در ٪۳۱/۵ موارد ملاحظه شد. در ناحیه پاشنه سمها در فیلمهای جانبی- میانی تغییرات عروقی در مقایسه با سمهای سالم ملاحظه نشد. تمام تغییرات عروقی در سمهای جانبی و میانی پاها یکسان بود و تغییرات معنی‌داری ($P>0.05$). بین دو سم دیده نشد که حاکی از این است که بیماری لامینیت یک بیماری عمومی است و تغییرات مشابه و یکسانی در هر دو سم بروز می‌دهد.

**نتیجه‌گیری و کاربرد بالینی**- در گاوهای شیری مبتلا به لنگش در اثر لامینیت تغییرات عروقی در انگشتان بوجود می‌آید و نیاز به توجه فوری برای جلوگیری از بروز لنگش در گاوهای شیری دارد.

**واژه‌های کلیدی**- گاوهای شیری، لنگش، لامینیت، آرتریوگرافی، انگشتان خلفی.