



In Horses With Chronic Laminitis, Do Venograms Compared to Plain Radiographs Give Greater Diagnostic or Prognostic Information?

A Knowledge Summary by

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Clinical bottom line

There is no conclusive evidence available to guide recommendations as to whether venograms provide any greater diagnostic or prognostic information compared to the use of plain radiographs in horses with chronic laminitis. Further evidence is needed to better answer this PICO.

Question

In horses with chronic laminitis, do venograms compared to plain radiographs give greater diagnostic or prognostic information?

Clinical Scenario

A 20-year old, obese Shetland pony mare with a history of recurrent episodes of acute laminitis is presented with reluctance to move, resistance to attempts to lift either of her front feet and weight shifting. Plain radiographs obtained on site reveal evidence of rotation of both the distal phalanges, consistent with a diagnosis of chronic laminitis. Should you proceed with further diagnostic imaging using contrast venograms to further inform your diagnostic or prognostic advice?

The Evidence

One publication was identified that compared concurrent findings of plain radiography and venograms to aid the diagnosis of chronic laminitis in a horse (Rucker, 2010b). This was a review article published in the peer-review journal '*Journal of Equine Veterinary Science*', within a special issue featuring the Proceedings of the 2nd Laminitis West Conference, Monterey, California in September 2010. As the data presented referred to only one horse, this publication is graded level 4 (case report) according to the 2011 Oxford Centre for Evidence-Based Medicine (OCEBM) Levels of Evidence¹.

Whilst a number of other review articles were identified from literature search on the subject of venography in horses, these did not include empirical comparative data between plain radiographs, and screening of all referenced primary research, including conference proceedings, also failed to identify any relevant data.

Summary of the evidence

Rucker (2010b)	
Population:	18-year old American Saddlebred gelding with insulin-resistance. Presented with a history of six-hour bilateral forelimb lameness and elevations in digital pulse pressure in all four limbs, subsequent to being ridden on trails one week earlier. Bruising of the sole had been

¹ OCEBM Levels of Evidence Working Group*. "The Oxford 2011 Levels of Evidence". Oxford Centre for Evidence-Based Medicine. <http://www.cebm.net/index.aspx?o=5653> (Accessed 7th August 2017). * OCEBM Table of Evidence Working Group = Jeremy Howick, Iain Chalmers (James Lind Library), Paul Glasziou, Trish Greenhalgh, Carl Heneghan, Alessandro Liberati, Ivan Moschetti, Bob Phillips, Hazel Thornton, Olive Goddard and Mary Hodgkinson

	identified four days prior to presentation.
Sample size:	1
Intervention details:	Plain lateral radiographs, and lateral and dorsopalmar venograms taken of both front feet at initial presentation.
Study design:	Review article containing a case series of three animals, one of which had laminitis (i.e. empirical data relevant to this Knowledge Summary presented on one case).
Outcome studied:	Objective diagnosis of laminitis on the basis of radiographic and venographic findings with descriptive, plain radiographic and venographic images provided.
Main findings: (relevant to PICO question):	<p>Plain radiographs identified mild remodelling at the apex of the distal phalanx and narrow sole depth (7 mm in the most painful, right fore).</p> <p>The lateral venogram revealed reduced contrast in the circumflex vessels and corium of the sole, absence of sole papillae visible distal to the apex of the distal phalanx, distortion of the lamellar-circumflex junction around the apex of the distal phalanx, and alterations in the dorsal coronary vessels.</p> <p>The dorsopalmar venogram confirmed absence of contrast in the circumflex vessel and sole corium beneath the descended apex of the distal phalanx, with relatively normal medial and lateral sublamellar vascular beds.</p> <p>The authors concluded “the venogram helped confirm that the lameness was not because of solar bruising or shoeing, but was because of laminitis”.</p>
Limitations:	<p>Unclear quality of peer-review for special issue of conference proceedings.</p> <p>Single animal.</p> <p>Whilst subsequent imaging was undertaken, plain radiographs and venograms were not reported to have been repeated simultaneously. Sequential imaging of both modalities and their correlation with prognosis was not done.</p> <p>Provides low level evidence of an improved diagnosis of chronic laminitis using venograms compared to plain radiography.</p>

Appraisal, application and reflection

Equine laminitis is a highly debilitating, multifactorial disease of the foot that affects Equidae worldwide (Herthel and Hood, 1999, Hood, 1999a, Wylie et al., 2011). It remains a significant welfare concern due to the

potential for debilitating and unrelenting pain (Baxter, 1986, Collins et al., 2010, Cripps and Eustace, 1999a, Hunt, 1993, Luthersson et al., 2017, Menzies-Gow et al., 2010).

The common feature of all laminitis cases is the induction of pathological changes within the suspensory apparatus of the distal phalanx (SADP) (Collins et al., 2010, Hood, 1999b). 'Acute' laminitis refers to the development of clinical signs associated with foot pain considered to represent pathological changes of the lamellar attachments, manifest as changes in the normal stance and gait of the animal (Baxter, 1994, Swanson, 1999, Wylie et al., 2013, Wylie et al., 2016). Acute laminitic cases can either progress to complete recovery, persist in a subacute form, or develop to 'chronic' laminitis (Hood, 1999b). The terminology used to describe chronic laminitis is extremely variable (Parks and Mair, 2009), but is commonly considered to occur when there is dislocation of the distal phalanx, as failure of the SADP disrupts the normal suspension of the appendicular skeleton within the hoof capsule (Collins et al., 2010, Hood, 1999b, Obel, 1948). Diagnosis of chronic laminitis is often hampered by the variability of clinical presentation (Wylie et al., 2013, Wylie et al., 2016), influenced by the underlying aetiology, concurrent disorders, disease phase and number of feet involved (Hunt and Wharton, 2010). Traditionally, the perceived 'gold-standard' diagnosis of chronic laminitis has included evidence of capsular and/or phalangeal rotation ('founder'), distal displacement of the distal phalanx ('sinker'), remodelling at the apex of the distal phalanx and the presence of gas lines, identified by standard, non-contrast ('plain') radiography (Cripps and Eustace, 1999a, Cripps and Eustace, 1999b, Eustace, 2010, Hunt and Wharton, 2010). However, plain radiographs are unable to provide visualisation of the corresponding digital vasculature and soft tissue damage (Baldwin and Pollitt, 2010, Eastman et al., 2012), and the lack of consensus regarding the evaluation of laminitic cases (Cripps and Eustace, 1999b, Hunt, 1993, Stick et al., 1982), suggests the need for appraisal beyond clinical examination and plain radiographic findings.

Vascular perfusion casts have previously been identified to reveal macroscopic perfusion defects in the distal digit of chronic laminitis cases compared to controls (Hood et al., 1994). The development of a digital venography technique in the early 1990s demonstrated retrograde filling of the digital veins following injection of radiopaque contrast fluid into the lateral digital vein and potential clinical application in the standing horse using standard radiographic equipment and a tourniquet following injection into the digital palmar or plantar veins (Baldwin and Pollitt, 2010, D'Arpe and Bernardini, 2010, Redden, 1993, Redden, 2001, Rucker, 2010a). Digital venography illustrates the major areas of interest including the bulbar vessels, circumflex vessels, coronary plexus, dorsal lamellar vessels and terminal arch (Arthur and Rucker, 2003, D'Arpe and Bernardini, 2010). In the healthy equine digit, venography reveals consistent digital vasculature without perfusion deficits, including filling of the venous vessels and retrograde arterial filling in some cases (Arthur and Rucker, 2003, D'Arpe and Bernardini, 2010, Redden, 2001, Rucker, 2003a, Rucker, 2003b, Rucker et al., 2006, Rucker, 2010c). In both experimentally-induced and naturally-occurring chronic laminitis it is reported that venography highlights notable perfusion deficits (Arthur and Rucker, 2003, Baldwin and Pollitt, 2010, D'Arpe and Bernardini, 2010, Rucker, 2010a).

This Knowledge Summary sought to gather peer-reviewed comparative data regarding concurrent plain radiographic and venographic findings in laminitic cases to appraise the evidence for improved diagnostic or prognostic indications following the use of venograms. No prospective studies, designed to quantify the sensitivity and specificity of the diagnostic modalities were identified. Only one conference proceeding identified by the search presented venographic data, yet presented no comparative plain radiographic data (D'Arpe and Bernardini, 2008). Due to the limited success, all potentially relevant review articles were also sourced and screened to identify any empirical data contained within them. All bibliographies from the retrieved articles and review articles were hand-checked and potentially relevant articles sourced. Furthermore, the leading researchers in the field, in Australia, Europe and the United States, were contacted to obtain any other relevant grey literature evidence.

Single case reports of venographic findings in laminitic horses were presented in eight conference proceedings (Arthur and Rucker, 2003, D'Arpe, 2007, D'Arpe, 2008, D'Arpe and Bernardini, 2008, Lyle, 2002, Pittman, 2016, Rucker et al., 2006, Redden, 2008), and in four review articles (Baldwin and Pollitt, 2010, D'Arpe and

Bernardini, 2010, Eastman et al., 2012, Rucker, 2010c). None of these publications presented concurrent plain radiographic findings, yet many anecdotally discussed the merits of undertaking venograms in chronic laminitis, stating that venography can predict distal phalangeal displacement and the associated vascular changes in advance of their occurrence, even whilst the foot looks normal on plain radiographs (Arthur and Rucker, 2003, D'Arpe and Bernardini, 2008, D'Arpe and Bernardini, 2010, Eastman et al., 2012, Rucker, 2010c). The review article by Baldwin and Pollitt (2010) referred to data presented in a MSc thesis publicly available through the University of Queensland website (Baldwin, 2012). This prospective clinical study investigated venographic changes in 10 Standardbred horses with no known prior history of laminitis, no clinical lameness and normal foot conformation, in which laminitis was induced using the carbohydrate (oligofructose) overload model. Although the data were not presented, as time progressed plain radiographs showed gradual dislocation of the distal phalanx within the hoof of the most severe of the six treated horses, whilst concurrent venography showed dramatic compression of dorsal venous compartments interpreted as progression of distorted hoof growth likely to contribute to pathological lysis of the distal phalanx. The authors stated that venographs allowed clinicians to detect and treat laminitis at a much earlier time point than relying on plain radiographs alone, enabling early diagnosis of irreversible changes that timely intervention could have prevented. A close correlation is also anecdotally reported to exist between prognosis, venographic findings, clinical and radiographic evidence of pathologic changes within the foot, in approximately 1000 laminitis cases (Rucker et al., 2006), with venograms reportedly providing superior prognostic information (Baldwin and Pollitt, 2010, D'Arpe and Bernardini, 2010, Pollitt, 2008, Redden, 1993).

The only identified evidence related to the clinical scenario was, therefore, one review article published in the *Journal of Equine Veterinary Science*, as summarised in the Summary of Evidence (Rucker, 2010b). Whilst this is a peer-reviewed journal, this was published as a special issue featuring the Proceedings of the 2nd Laminitis West Conference, Monterey, California in September 2010, and it is unclear whether such issues undergo the same degree of peer-review. This was a descriptive report which presented concurrent radiographic and venographic findings in a single horse with chronic laminitis. The authors stated that venography helped confirm a diagnosis of laminitis, providing low level evidence regarding the value of venograms compared to radiographs in the diagnosis of chronic laminitis.

In conclusion, this Knowledge Summary failed to find any evidence of any prospective, comparative clinical studies between the findings of plain radiography and venography and their association with the diagnosis or prognosis of chronic equine laminitis. As this systematic scrutiny of the available evidence identified a knowledge gap, a strong justification for publication of original research is therefore apparent (Lund et al., 2016). It was apparent from the data discussed in review articles and conference proceedings that a large number of venograms have been undertaken in clinical practice and these authors should be encouraged to provide an empirical evidence-base for the use of venograms as a diagnostic and prognostic modality for chronic laminitis. A simple retrospective case series providing descriptive data regarding both plain radiographic and venographic changes relative to diagnosis and outcome in clinical cases would provide a foundation for more robust observational and experimental studies. If indicated, future work should include prospective, comparative clinical studies designed to quantify the sensitivity and specificity of the diagnostic modalities. If data indicating a benefit of venography can be documented, then the effort and expense of undertaking venographic imaging in the chronic laminitic would become more justifiable than the current lack of evidence supports.

Methodology Section

Search Strategy	
Databases searched and dates covered:	(A) CAB Abstracts on the OVID interface (1973 to 2017 Week 10) (B) PubMed database, accessed via the NCBI website (Last 20 years 1997-), veterinary science filter applied.
Search terms:	<p>(A)</p> <ol style="list-style-type: none"> (equine* or horse* or equus or colt* or pony or ponies or mares or filly or fillies or gelding* or stallion* or yearling* or thoroughbred or standardbred or warmblood).mp. or equidae/ or equus/ or horses/ or foals/ or colts/ or mares/ or stallions/ (laminitis or laminitic or founder).mp. or exp laminitis/ (venogram or venograms or venography or venographic or phlebography or phlebographic or phlebogram or phlebograms).mp. (radiograph or radiographs or radiography or radiographic).mp. or radiography/ 1 and 2 and (3 or 4) (170) <p>(B)</p> <ol style="list-style-type: none"> Horse laminitis or founder radiography venogram or venography or phlebogram or phlebography 1 and 2 and (3 or 4)
Dates searches performed:	22-23 / 03 / 2017

Exclusion / Inclusion Criteria	
Papers were initially screened on title and abstract, and all potentially relevant articles were retrieved in full-text format. There were no pre-specified limitations regarding study design, study location or sample size.	
Exclusion:	Non English-language publications
Inclusion:	<p>Primary research papers</p> <p>Conference proceedings</p> <p>Review articles with empirical data</p> <p>Horses or ponies with chronic laminitis (defined as displacement of the distal phalanx, irrespective of duration)</p> <p>Both concurrent plain radiographic and venographic findings presented</p>

Search Outcome						
Database	Number of results	Excluded – did not answer PICO question	Excluded – not English language	Excluded – conference abstract only	Excluded – duplicates	Total relevant papers
NCBI PubMed	25	23	0	0	0	2
Thomson Reuters Web of Science	25	22	1	0	2	0
CAB Direct	46	41	1	2	2	0
Science Direct	251	251	0	0	0	0
Total relevant papers when duplicates removed						2

CONFLICT OF INTEREST

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