Pulse wave velocity in palmar medial and palmar digital arteries in equine front limbs - a pilot study

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Introduction

Increased arterial stiffness is implicated in the pathogenesis of cerebral and renal microvascular lesions in humans[1], which are comparable to those seen in laminitic horses. Systemic inflammation and hyperinsulinemia are both known triggers of laminitis[2], and increase arterial stiffness in humans[3,4]. This study aims to develop a technique to determine pulse wave velocity (PWV), a marker of arterial stiffness, in equine distal limbs.

Methods

Ten Standardbred racing horses with no history of cardiovascular disease or laminitis were used. Inclusion criteria included normal physical examination, haematology, serum biochemistry analysis, cardiac ultrasonography and latero-medial distal limb radiographs.

For data collection, horses were kept in crossties in their barn, unsedated. B-mode Doppler ultrasound of the Palmar Medial (PMA) and Palmar Digital arteries (PDA) at the fetlocks (f) and pasterns (p) was sequentially done on both front limbs (figure 1); ECG was done simultaneously. The resulting Doppler flow speed waves were timed with the ECG (figure 2). The distances between ultrasound sites were measured. PWV was calculated based on wave transit time and distance between locations using the formula:

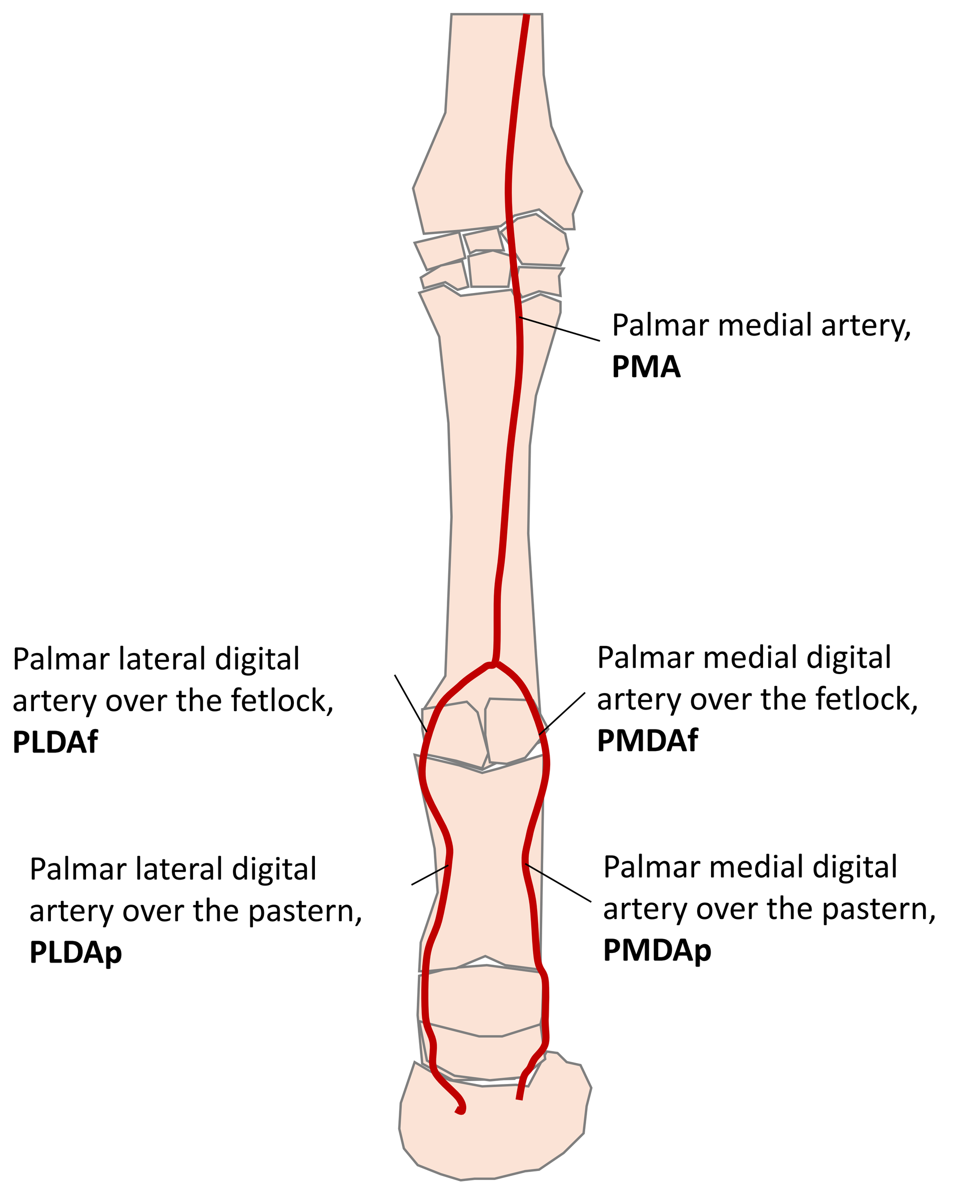

Figure 1- Representation of palmar view of equine left front limb indicating the position of the arteries being examined.

$$\mathrm{PWV} = \frac{distance\ between\ locations,\ \Delta d}{wave\ transit\ time,\ \Delta t}$$

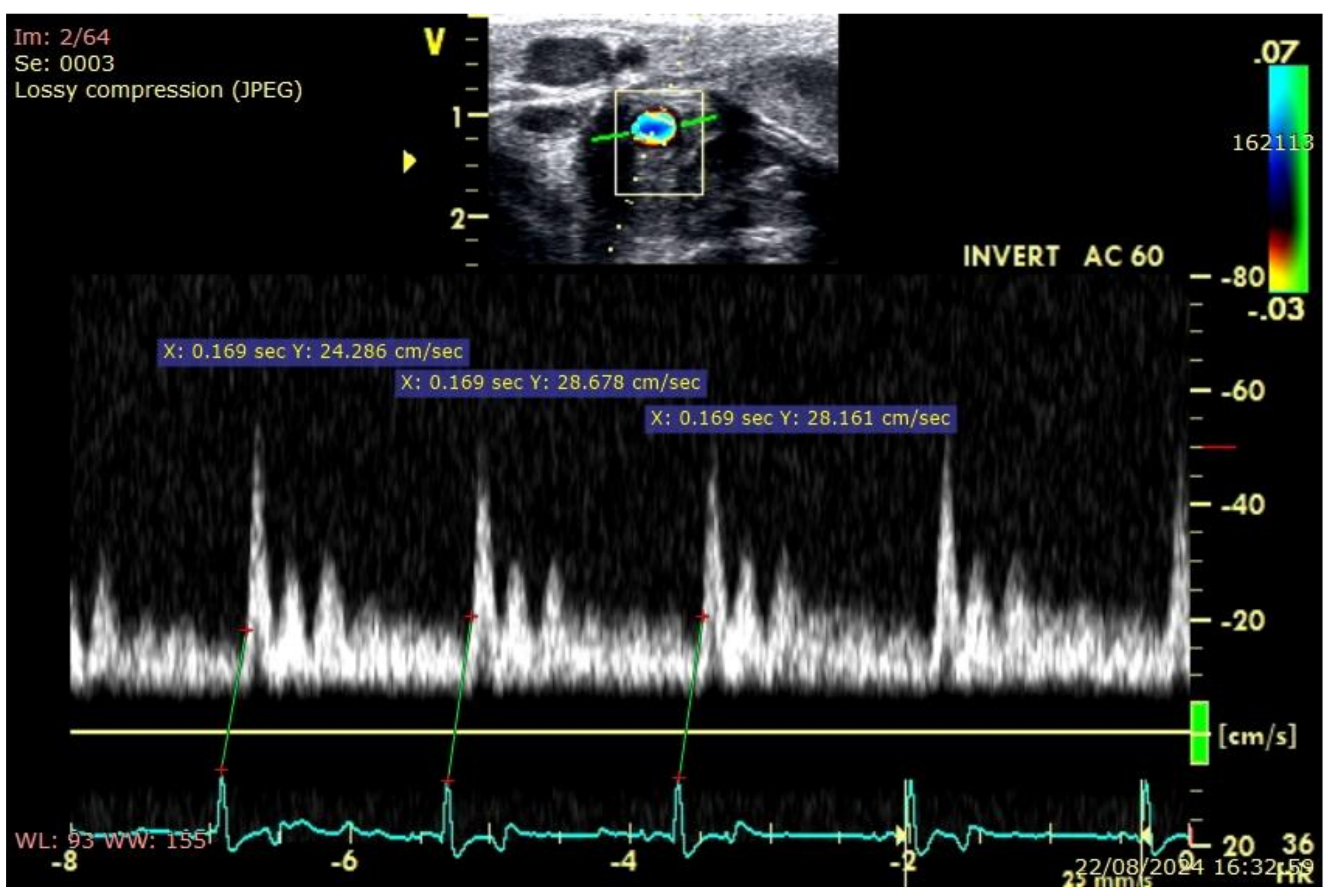

Figure 2- Timing Doppler flow speed waves with concurrent ECG tracing (left PMA horse #7).

Results

- 35/120 PWV data readings were excluded from the final analysis if either considered unfeasible negative velocities or outliers.
- 18/35 results removed were for the PDAf-PDAp PWV sections.
- 26/35 results removed were from the left front limb, which was the first to be assessed in every horse.

Table 1- Summary of results. Mean HR LF/RF – Mean heart rates during data collection from left front limb and right front limb respectively. NBIP – MAP- Mean arterial pressure measured non-invasively prior to ultrasound data collection. NBIP – PP- pulse pressure measured non-invasively prior to ultrasound data collection. Dark orange cells – PWV values arbitrarily deemed impossible. Light orange cells- PWV values outside of Mean±1,5*IQR for remaining PMA-PDAf, PMA-PDAp and PDAf-PDAp values.

Horse #		1	2	3	4	5	6	7	8	9	10
Sex		MC	MC	MC	F	F	MC	MC	MC	MC	F
Age (years)		8	4	5	5	7	4	4	8	6	4
HR LF/RF (bpm)		33/32	35/32	34/33	33/32	32/35	38/37	33/32	33/34	36/33	34/33
MAP (mmHg)		84	73	73	85	77	82	98	88	89	75
PP (mmHg)		47	53	39	45	36	54	37	43	48	31
Left	PMA-PMDAf	79,1	5,8	18,9	13,2	11,1	-12,7	15,6	28,7	20,3	21,1
	PMDAf-PMDAp	11,3	55,4	4,1	8,9	-96,0	3,0	9,6	54,0	3,9	51,4
	PMA-PMDAp	34,3	7,1	10,8	12,0	14,6	175,5	13,8	32,2	10,8	24,0
	PMA-PLDAf	-45,8	7,3	13,5	16,1	22,8	-20,6	20,7	14,9	15,0	38,9
	PLDAf-PLDAp	11,4	7,1	4,1	7,7	72,0	4,8	7,7	9,9	6,5	4,8
	PMA-PLDAp	855,0	7,3	9,2	13,2	20,6	360,0	15,4	13,4	11,8	16,0
Right	PMA-PMDAf	9,7	20,1	14,9	15,7	17,7	14,7	17,1	23,1	12,5	16,4
	PMDAf-PMDAp	17,1	-13,1	45,0	6,5	6,7	4,8	5,2	12,5	8,2	6,7
	PMA-PMDAp	10,7	43,1	17,3	12,1	13,3	10,3	11,5	19,3	11,3	12,3
	PMA-PLDAf	9,1	17,4	12,7	22,5	18,2	10,3	11,3	27,4	19,4	15,2
	PLDAf-PLDAp	16,4	-5,9	11,4	6,2	4,0	7,8	144	8,2	6,1	8,3
	PMA-PLDAp	10,1	91,6	12,4	14,8	10,7	9,7	13,9	17,9	13,4	13,0

- Mean (±SD) PMA-PDAf PWV was 16,2m/s (±4,6).
- Mean (±SD) PDAf-PDAp PWV was 9,2m/s (±3,1).
- Mean (±SD) PMA-PDAp PWV was 13,2m/s (±2,8).

Conclusions

The PWV could be determined in unsedated horses, stall side using a non-invasive and readily available technique. Increasing control over patient stress factors and a larger cross-sectional study should provide the recording of reference values in healthy horses.

Clinical relevance

Establishing the normal reference values of PWV to the equine foot will contribute to further understand the potential role of changes in arterial stiffness in the pathophysiology of laminitis. This technique is easy, readily available and should be validated in a larger sample size cohort.

Aknowledgements:

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