

Agreement Between Doppler and Invasive Blood Pressure Monitoring in Anesthetized Dogs Weighing <5 kg.

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Author information

Abstract

The objectives of this study were to determine if Doppler (DOP) blood pressure measurements more closely estimate either invasive systolic or invasive mean arterial blood pressures (ISAP or IMAP, respectively) in small dogs under general anesthesia and to assess the ability of DOP to detect anesthesia-related hypotension in small dogs. Blood pressure measurements (n = 203) were obtained from 10 client-owned dogs. DOP, ISAP, and IMAP were recorded simultaneously, and the data were categorized into two groups: hypotensive (ISAP <90 mm Hg) and normotensive (ISAP ≥90 mm Hg and ≤160 mm Hg). DOP overestimated ISAP and IMAP in both the normotensive and hypotensive groups. The DOP was highly specific (97%) but poorly sensitive (56%) for detecting hypotension. The smallest bias was achieved when using DOP as an estimate of systolic arterial blood pressure in both normotensive and hypotensive dogs, suggesting that DOP measures systolic arterial blood pressure in dogs <5 kg. For dogs with hypotension, DOP met all of the performance criteria for noninvasive blood pressure monitors recommended by the American College of Veterinary Internal Medicine. DOP is an acceptably accurate and highly specific means of detecting hypotension in small dogs under general anesthesia.

Objectives:

1. determine if DOP is a better estimate of SAP or MAP in anesthetized dogs < 5 kg.
 - a. other investigations comparing DOP to IBP used medium to large breed dogs and found DOP to estimate ISAP
 - b. in cats DOP found to estimate IMAP
 - c. some speculate in small dogs DOP may also estimate IMAP but no study
 - d. important to determine when to intervene during a hypotensive event
2. assess DOP accuracy to detect spontaneous hypotension in this population

Methods:

1. University of Minnesota
 - a. patients undergoing GA for imaging and surgery
2. Inclusions
 - a. arterial catheter already in place as part of monitoring plan for anesthesia

- b. BW < or = 5 kg
- 3. all received supervision of boarded anesthesiologist
- 4. procedure
 - a. premed, catheter, anesthesia according to anesthesiologists plan
 - b. intubated and maintained on either iso or sevo
 - c. IV fluids at 5-10 mL/kg/hr
 - d. temp, HR, RR continuously monitored and recorded q5mins
 - e. pulse ox and ECG
 - i. Hgb sat, HR, rhythm
 - f. 22-24 gauge over the needle catheters in right or left dorsal pedal artery connected to previously calibrated disposable pressure transducer by low compliance pressure tubing filled with heparinized saline from pressurized bag (300 mm Hg). hep saline 3 mL/hr to prevent clot formation
 - i. lateral or dorsal recumbency according to procedure and pressure transducer at level of right atrium. transducer connected to BP monitor and zeroed. BP continuously monitored. ISAP and IMAP recorded simultaneously and at same time as DOP.
 - g. for DOP: forelimb or hindlimb contralateral to arterial catheter fitted with BP cuff proximal to tarsus or carpus (limb determined by accessibility during procedure)
 - h. pressures were recorded q5mins.
 - i. normotension defined as ISAP > or = 90 mmHg and < or = 160 mm Hg
 - j. hypotension defined as ISAP < 90 mm Hg
 - k. efforts were made to keep pressures above 60 mmHg during anesthesia
 - i. hypotension addressed by decreasing level of inhalant
 - ii. administering IV fluids
 - iii. administering dobutamine and or dopamine

Stats

- 2 categories: hypotensive or normotensive
- agreement between DOP and IBP used bland altman method
 - when comparing DOP and ISAP mean bias and st dev calculated by subtracting DOP from ISAP
 - positive bias indicated DOP underestimates ISAP
 - negative bias indicated DOP overestimates ISAP
 - similar for IMAP calculations
- ability of DOP to detect hypotension used 2 x 2 table with binary outcome
 - sensitivity
 - specificity
 - negative predictive value
 - positive predictive value

Results

- 8 month investigation
- 10 client owned pets

- 5 males and 5 females
- 8 mos to 12 years
- mean BW 3.85 +/- 0.9 kg
- measurements
 - hypotensive 103 paired BP readings
 - normotensive 100 paired BP readings
- in both groups DOP overestimated SAP and MAP
 - smallest bias when used as estimate of ISAP in both groups
 - in both groups DOP overestimated IBP to greater extent as IBP increased
- how close?
 - for hypotensive: 61.2% were within 10 mmHg ISAP
 - for normotensive: 60% were within 20 mmHg ISAP
 - DOP 97% specific for detecting hypotension (PPV 95%)
 - DOP 56% sensitive with NPV 68%
 - DOP overestimated ISAP by mean of 5.7 mm Hg (+/- 12.3 mm Hg)
 - DOP more accurate measurement of SAP at hypotension
- only the DOP as estimate of ISAP in hypotensive dogs fulfilled the ACVIM criteria
 - absolute bias < or = 10 mmHg
 - 50% of all measurements lie within 10 mm Hg of reference method
 - 80% all measurements lie within 20 mm Hg of reference method

Discussion

- high specificity and high PPV make it good tool for ruling in hypotension
- but hypotension may be missed due to low sensitivity and low NPV
- we usually want to rule out hypotension so IBP still indicated with significant hemorrhage or difficult to manage hypotension (septic patients)
- limitations
 - 10 dogs and 203 paired measurements
 - different anesthetists performing DOP
 - anesthetist not blinded to IBP readings
 - not all in same position
 - cuffs on different limbs
 - depending on surgery not all had DOP cuff at level of heart, may have contributed to overestimation of ISAP. but likely small due to small size of patient and need for cuff to be 10 cm below heart to overestimate BP by 7 mm Hg
- treat hypotension indicated by DOP in small patients.

Left ventricular structural and functional abnormalities in dogs with hyperadrenocorticism.

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Author information

Abstract

OBJECTIVES:

Hyperadrenocorticism has been reported to cause left ventricular (LV) structural and functional abnormalities in human patients. The purpose of the present study was to assess the incidence and features of LV structural and functional changes in dogs with hyperadrenocorticism.

ANIMALS:

Twenty-two client-owned dogs with pituitary-dependent hyperadrenocorticism (n = 15) and cortisol-secreting adrenocortical tumors (n = 7) and 6 control dogs were enrolled in this study.

METHODS:

Echocardiographic examinations were performed and non-invasive measurements of systolic blood pressure (SBP) were obtained.

RESULTS:

The normalized LV wall thickness and LV mass index of the affected dogs differed significantly from those of control dogs. Using a published reference value for M-mode measurements, 15 of the 22 dogs (68%) were found to have increased LV wall thickness. Eleven of the 15 (73%) dogs with increased LV wall thickness were normotensive, and no significant correlation between LV wall thickness and SBP was found.

CONCLUSIONS:

Regardless of the presence of systemic hypertension, hyperadrenocorticism should be included in the differential diagnosis of underlying disorders that may cause LV hypertrophy in dogs.

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Intro

- systemic hypertension is a complication of prolonged excessive secretion of cortisol (as are pyelonephritis, cystic calculi, glomerulonephropathy, pancreatitis, DM, PTE, and pituitary macro-tumor syndrome)

- increased risk of cardiovascular events and LV structural changes in people
- purpose of study: evaluate LV structure and function with hyperadrenocorticism using transthoracic echo.

Methods:

- Azabu University VTH between march and july
 - diagnosed
 - previously diagnosed but present for recheck evaluations
 - all dogs at hospital for hyperadrenocorticism got an echo
 - hyperadrenocorticism diagnosed via PE, CS, adrenal gland ultrasonography (> 6 mm of maximum transverse diameter), biochemical profile, ACTH stim (post >20 mcg/dL serum cortisol), low dose dex suppression test (serum cortisol > 1 mcg/dL 8 hours after dex)
 - dogs dx as either pituitary dependent or cortisol secreting adrenocortical tumor
 - dogs with no evidence of systemic disease based on PE, SBP, CBC/CHEM, rads, and echo used as controls. those with similar degree of chronic valvular heart disease and pulmonary hypertension were finally included as controls.
- measurements of arterial SBP
 - SBP measured via doppler
 - SHT defined as SBP > 160 mmHg
- Echocardiography
 - all imaged in right and left lateral recumbency
 - 7-10 mHz transducer
 - right parasternal LV short axis view at level of chordae tendinae: M mode measurements included:
 - LV end diastolic diameter
 - LV end systolic diameter
 - LV posterior wall thickness in end diastole
 - LV posterior wall thickness in end systole
 - interventricular septal thickness in end diastole
 - interventricular wall thickness in end systole
 - measurement normalized using body weight according to results of regression analysis by Cornell et al
 - fractional shortening also calculated
 - LV structural abnormality when normalized end diastolic LV wall thickness OR LV internal diameter deviated from predicted interval
 - classification of LV remodeling
 - asymmetric pattern defined as IVSd/LVPWd ratio > 1.3 or < 0.7
 - relative wall thickness, LV mass, LV mass index assessed

- 2 DE was used to obtain diameters of LA and aortic root from right parasternal LV short axis view at level of aortic root. La/Ao calculated. La/Ao > 1.57 indicated left atrial enlargement
- transmitral flow obtained to measure velocities of early and late diastolic waves (E and A waves). aortic blood flow velocity measured as well.
- concurrent CV disorders evaluated as well.

STATS:

- Mann Whitney U test, Fishers, Spearman's rank order correlation test
- $p < 0.05$ significant

Results:

- prevalence and severity of CVHD and PH similar between controls and hyperadrenocorticism dogs
- systemic hypertension in 5 dogs with hyperadrenocorticism
 - no evidence of dehydration or renal dysfunction
- all dogs in control group normotensive
- compared to control hyperadrenocorticism dogs had significantly higher:
 - LVPWdN (left ventricular posterior wall thickness in end diastole, normalized)
 - LVPWsN (left ventricular posterior wall thickness in end systole, normalized)
 - IVSdN (normalized interventricular septal wall thickness in end diastole)
 - LNM & LVMI (left ventricular mass index)
 - but no difference in M mode variables or relative wall thickness, 2DE or Doppler mode variables
- LV structural abnormalities in 15/22 (68%) of dogs with hyperadrenocorticism
 - increased LV wall thickness in 11/15 dogs with pituitary dependent hyperadrenocorticism
 - 4/7 dogs with adrenal tumors
 - 4 dogs with SHT had increased LV wall thickness
 - No significant difference in SBP between study dogs with and without increased LV wall thickness, nor correlation between LV wall thickness and SBP
 - 5/22 presented with SHT and 4/5 had increased LV wall thickness
 - LVM and LVMI significantly increased in untreated dogs compared to treated dogs.
 - 14 of 22 dogs (64%) also had CVHD
 - 6/20 dogs had abnormal relaxation pattern of transmitral inflow (E/A ratio < 1.0)

Conclusions

- canine hyperadrenocorticism frequently associated wt. LVH
- SHT has been reported to be secondary to hyperadrenocorticism, and may induce LVH. however, majority of dogs in this study with increased LV wall thickness did not present with SHT.
- hyperadrenocorticism should be included in the differential diagnosis of dogs with LVH regardless of presence of SHT.
- in humans patients adrenalectomy reported to reverse myocardial fibrosis and normalize LV structure and function.

Limitations

- only echo and clinical exams were used, so other myocardial disorders could not be ruled out
- only SBP (doppler) used to measure SBP
- correlation between LVH and cortisol blood concentration not further evaluated
- small control group (n=6), trend regarding age (thought not significant)
- dogs on medications included in study

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Acute resolution of pulmonary alveolar infiltrates in 10 dogs with pulmonary hypertension treated with sildenafil citrate: 2005-2014.

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Author information

Abstract

OBJECTIVE:

To describe clinical canine patients with naturally occurring pulmonary hypertension and radiographic pulmonary alveolar infiltrates before and after treatment with sildenafil.

ANIMALS:

Ten client-owned dogs.

METHODS:

A retrospective analysis of dogs with echocardiographically-determined pulmonary hypertension and pulmonary alveolar infiltrates on thoracic radiographs was performed before (PRE) and after (POST) sildenafil therapy. Clinical scores, pulmonary alveolar infiltrate scores and tricuspid regurgitation gradients were analyzed PRE and POST sildenafil.

RESULTS:

Pulmonary alveolar infiltrates associated with pulmonary hypertension developed in a diffusely patchy distribution (10/10). Sixty percent of dogs had a suspected diagnosis of interstitial pulmonary fibrosis as the etiology of pulmonary hypertension. Median PRE clinical score was 4 (range: 3-4) compared to POST score of 0 (0-2) ($p = 0.005$). Median alveolar infiltrate score PRE was 10 (5-12) compared to POST score of 4 (0-6) ($p = 0.006$). Median tricuspid regurgitation gradient PRE was 83 mmHg (57-196) compared to 55 mmHg POST (33-151) ($p = 0.002$).

CONCLUSIONS:

A subset of dogs with moderate to severe pulmonary hypertension present with diffuse, patchy alveolar infiltrates consistent with non-cardiogenic pulmonary edema. The typical clinical presentation is acute dyspnea and syncope, often in conjunction with heart murmurs suggestive of valvular insufficiency. This constellation of signs may lead to an initial misdiagnosis of congestive heart failure or pneumonia; however, these dogs clinically and radiographically improve with the initiation of sildenafil.

objective:

to describe clinical canine patients with naturally occurring PHT and radiographic pulmonary alveolar infiltrates before and after treatment with sildenafil.

Introduction:

- diagnosed with echocardiogram
- estimated pulmonary arterial systolic pressure > 30 mmHg
- thoracic radiographs may show consequences of long term PH including pulmonary arterial enlargement and right sided heart enlargement
- occurrence of pulmonary alveolar infiltrates associated with PH in dogs not well described and may be under-recognized feature of PH

Materials and Methods

- University of Wisconsin
- patients with concurrent radiographic evidence of pulmonary alveolar infiltrates, moderate to severe pulmonary hypertension based on echocardiographic examination and treatment with sildenafil citrate from June 2005 to March 2014
- Inclusion criteria
 - recent heartworm testing
 - 3 view thoracic rads pre and post sildenafil treatment
 - echocardiograms pre and post that included estimated systemic pulmonary artery pressures based on peak tricuspid regurgitation flow gradients (NOTE post echo did not always coincide with post t-rads)
 - n = 10
- clinical score
 - pre and post
 - scores based on clinical presentation and owners assessment of dogs well being
 - 0 = no clinical signs
 - 1 = identifiable signs but mild to moderate impact on life
 - 2 = overt clinical signs such as exercise intolerance, syncope, respiratory distress, cough)
 - owners assessment:
 - 0: unaffected dog
 - 1: good QOL
 - 2: poor QOL
- maximum score = 4

thoracic rads

- boarded radiologist blinded to pre and post treatment
- VHS from left lateral in all dogs

- VD for pre and post assessment of severity of pulmonary alveolar infiltrates (modified murray lung injury score)
 - lung fields divided into 4 quadrants and each quadrant given score of 0-4
 - 0 = no pulmonary alveolar infiltrates
 - 1 = pulmonary alveolar infiltrates 0-25% quadrant
 - 2 = 25-50%
 - 3 = 50-75%
 - 4 = 75-100%
 - total number from each quadrant combined for total possible score of 16

Echocardiogram

- mild PH sPAP 30-50 mmHg
- moderate PH sPAP 51-75 mmHg
- severe > 75 mmHg
- La/Ao for all prior to start (1.5 cut off)
- presence/absence of mitral regurge recorded for all PRE
- full echo pre and full or partial post

STATS

- Wilcoxin signed rank $p < 0.05$

Results

- median age 13 yrs (2-22 yrs)
- median weight 5 kg (2.6-11.4)
- some treated with furosemide and/or antibiotics without clinical improvement prior to presentation
- 7/10 required O₂ therapy but did not improve on oxygen alone
- Once tentative diagnosis of PH made sildenafil administered orally to all dogs
 - median dose 1.0 mg/kg PO q8 hrs (range 0.5-2.0 mg/kg)
 - median POST significantly lower compares to PRE
 - mean HR 152 PRE to 40 POST
 - mean RR 100 PRE to 40 POST
 - mean CS 4 PRE to 0 POST
 - mean pulmonary infiltrate score 10 PRE to 4 POST
 - no other medications administered between pre and post including furosemide
 - median follow up time 9 days (range 3-36)
 - murmurs in 7/10 PRE
 - 3 dogs had normal respiratory auscultation PRE and POST

- 4 had diffuse pulmonary crackles PRE, 7 dogs POST
- 3 had harsh BV sounds PRE
- 4 had cyanotic MM PRE (0 post)
- ECG 7/10 on presentation
 - 3 right axis deviation, 1 left ventricular enlargement pattern, 1 solitary atrial premature complex, 2 sinus tachycardia
- thoracic rads pre showed varying degrees of patchy alveolar infiltrates
 - PRE: subjective LA enlargement 2 dogs, 5 mild RA enlargement, 2 moderate right side enlargement
 - POST rads median 3.5 days range of 1-12 days
 - subjective enlargements remained unchanged
 - pulmonary vasculature size on all dogs normal pre and post
 - median alveolar infiltrate score post significantly improved compared to PRE and median VHS PRE and POST not different.
- post echos median 8 days (1-47) after initial echo
 - PRE 5 mild MR, 1 moderate MR (myxomatous mitral valve disease). median la/ao 1.4, subjective right sided chamber dilation in 9/10 dogs, 4 right ventricular concentric hypertrophy, 5 septal flattening
 - estimated sPAP significantly decreased POST compared to PRE
 - 6 dogs (60%) suspected to have PH due to idiopathic interstitial pulmonary fibrosis (1 confirmed at necropsy)
 - 2 idiopathic PH
 - 1 chronic respiratory disease
 - 1 had TEG results suggesting hypercoaguability so possible thromboembolism.
 - at time of manuscript 3 alive, 6 died/euthanized/ 1 lost to follow up (mean time to final outcome 249 days)

Conclusions

- pulmonary alveolar infiltrates can occur in dogs with PH and typical presentation is acute dyspnea with syncope and presence of valvular insufficiency murmurs.
- sildenafil had positive impact on CS and QOL, improved/resolved pulmonary alveolar infiltrates and ameliorated pulmonary hypertension
- efficacy in these cases suggests PH causes not only by fixed increase in pulmonary vascular resistance but also substantial degree of reactive

vasoconstriction and sildenafil may improve these infiltrates by decreasing over-perfusion to edematous areas.

Limitations

- true prevalence during study period not known
- # with pulmonary crackles POST higher (inter observer versus loud adventitial sounds PRE)
- no control group (ethics)
- tricuspid regurgitation gradients as surrogates of PH severity (inconstancies)
- only 1 necropsy and 0 CT (error in diagnosis?)
- limited time frame/follow up