Introduction

The donkey (Equus asinus) is an important working animal in many areas of the world, but in the UK, donkeys are predominantly companion or leisure animals. The total number of donkeys worldwide has been estimated as $44 \times 10^6$ but in the UK, estimated numbers are 10,000 (Starkey and Starkey 1996). Approximately 35 per cent of these UK donkeys are maintained by the Donkey Sanctuary (DS), Devon.

Given the importance of this animal for work in many parts of the world there is a dearth of information about the donkey and it is often wrongly treated as a small horse (Senior 2013). There are publications about physiological variables for donkeys for working animals (Mueller and others 1994, Matthews and others 1998, Makoy and others 2005, Ayo and others 2008) including clinical pathology reference data (Folch and others 1998, Maloiy and others 2003, Ayo and others 2008). There are publications about physiological variables for donkeys for working animals (Mueller and others 1994, Matthews and others 1998, Makoy and others 2005, Ayo and others 2008) including clinical pathology reference data (Folch and others 1998, Maloiy and others 2003, Ayo and others 2008) including clinical pathology reference data (Folch and others 1998, Maloiy and others 2003, Ayo and others 2008). There are individual case reports of parasitism that can affect the donkey (Toliver and others 1985, Wells and others 1998, Uslu and Guclu 2007, Bu and others 2009, Asefa and others 2011, Matthews and Burden 2013). A large, retrospective review of postmortem results from 1444 sedentary donkeys (DS records) has recently provided valuable information about the frequency of conditions resulting in donkey morbidity (Morrow and others 2011). The mean age was 30.6 years, so geriatric diseases are likely to be over-represented. Valvular (33 per cent) and myocardial heart lesions (11.2 per cent) were not infrequent (Morrow and others 2011), although severity of these were not assessed. Since this survey reported pathological evidence of valvular heart disease in a third of donkeys, it is surprising that there is sparse clinical information regarding the premortem diagnosis of cardiac disease in donkeys, or the clinical relevance of lesions identified. Heart murmurs and degenerative valvular disease are common in geriatric horses (Sage 2002, Ireland and others 2012), particularly affecting the aortic valve (Else and Holmes 1972a). There are individual case reports of pacemaker implantation in donkeys with third degree atrioventricular block (Pibarot and others 1993) and a published letter about cardiac myopathy in a donkey foal (Dyson and others 1977).

Echocardiography is increasingly available as a tool to non-invasively screen for or diagnose cardiac disease in all species. Echocardiographic studies of healthy donkeys have been published in the literature to provide reference intervals (Delvaux and others 2001, Amory and others 2004, Hassan and Torad 2015), but information about structural or functional cardiac disease is lacking in this species, particularly in geriatric donkeys.

In the pathological survey (Morrow and others 2011), the prevalence of aneurysms was 43.1 per cent (typically the cranial...
mesenteric artery) and prevalence of other vascular disease was 60.9 per cent, with both occurring together in some animals (32.9 per cent). Whether vascular disease is an ageing change in donkeys, or is associated with strongylo infestation as in horses (Elle and Holmes 1972a) is not clear.

The aims of this observational, cross-sectional study were therefore (i) to screen a selection of apparently healthy, sedentary donkeys at the DS over a wide age range and to document auscultation findings including presence and frequency of arrhythmias and heart murmurs, (ii) to use echocardiography to screen for structural or functional heart disease in those with murmurs and a subset without, (iii) to review the DS Pathology Database for evidence and prevalence of cardiac and vascular disease, including some donkeys assessed by echocardiography. Finally, the authors wanted to compare veterinarians’ perceptions of the importance of heart disease in donkeys with the frequency of heart disease identified in this population at the DS.

Materials and methods
Donkeys and environment
Donkeys were owned by the DS, near Sidmouth, Devon, UK. They were maintained in groups, under similar conditions and management, housed in barns, with free access to an outdoor yard and grazing. Individuals were identified by name and number on collars. Clinical records for each donkey were available, since their arrival time at the DS. Age, sex and weight were retrieved. Current diet, whether on supplemental feed, recent faecal egg count and concurrent illnesses were all noted. Donkeys were examined by one observer (SLR) over two visits in February 2010 (four days) and October 2012 (three days).

Physical examination and auscultation
Individual donkeys were randomly selected based on their natural curiosity and willingness to be approached and examined by the examiner. The examinations were carried out during quiet periods, at a time when the donkeys were not being fed or otherwise handled. The weather was calm and dry, without wind.

Information recorded included demeanour, body condition score (BCS), respiratory rate and effort. Cardiac auscultation was systematically carried out (Blissitt 2010) using a Littman Cardiology III stethoscope over 5–10 minutes. The coat was not clipped or shaved before auscultation. Pulse quality was assessed from the facial artery. Heart rate and rhythm were recorded. The heart sounds detected (S1, S2, S3, S4) were noted for each case. The presence of any heart murmur was noted, and characterised by point of maximal intensity, grade of murmur (out of 6, Levine classification (Patteson and Cripps 1993) and timing. BCS out of 5 was determined (Swedsen 2008).

Results
The donkey population evaluated
A total of 202 donkeys underwent physical examination by auscultation. There were 117 males (all geldings) and 85 females. The ages, weights and BCS of donkeys are given in Table 1. There was no significant difference in ages between the sexes, but statistically significant differences between geldings (G) and females (F) indicated in bold.

Pathology
Some of the donkeys in the auscultation part of the study which died or were euthanased, underwent full postmortem examination at the DS as previously described (Moroz and others 2011). Cause of death/euthanasia was retrieved and postmortem examination reports reviewed, particularly in regard to cardiac or vascular lesions.

The full DS pathology archive of all postmortem examinations of donkeys which died/were euthanased between 2006 and 2010 was searched for ‘cardiac lesions’ and cardiac death, and numbers of cases retrieved.

Questionnaire
A survey was sent out to investigate the opinions of practising veterinary surgeons working in 12 equine, large animal or mixed veterinary practices from different geographical regions, on whether cardiac disease is a significant problem in pet donkeys. A total of 104 veterinary surgeons were invited to participate.

Statistical methods
Data were recorded in an Excel spreadsheet. Data were imported into SigmaPlot V13.0 for Windows (Systat software). Basic descriptive data are reported as means and sd if data were normally distributed or as medians (minimum–maximum) if not. The Shapiro-Wilk test was used to assess for normality. Comparisons between males and females used the Student’s unpaired two-tailed t-test for normally distributed data, or the Mann-Whitney test for non-normal distribution of data. Linear regression was used to explore associations between sets of variables.

For the questionnaire data, chi-squared analysis was used to assess the opinions of veterinarians as to the importance of clinically evident heart disease in donkeys (yes/no) with experience of examining donkeys (<0.05) with experience of examining donkeys (<0.05) with experience of examining donkeys (<0.05) with experience of examining donkeys (<0.05) with experience of examining donkeys (<0.05)

**Table 1: Population description for the auscultated donkeys**

<table>
<thead>
<tr>
<th>Description</th>
<th>All</th>
<th>Geldings</th>
<th>Females</th>
<th>P value between G/F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (kg)</td>
<td>176</td>
<td>180</td>
<td>170</td>
<td>0.014</td>
</tr>
<tr>
<td>Median (range)</td>
<td>119-363</td>
<td>124-277</td>
<td>119-363</td>
<td></td>
</tr>
<tr>
<td>BCS (5) median</td>
<td>3.5</td>
<td>3.5</td>
<td>3.5</td>
<td>0.481</td>
</tr>
<tr>
<td>(range)</td>
<td>(1-5)</td>
<td>(1-5)</td>
<td>(2-5.5)</td>
<td></td>
</tr>
<tr>
<td>(no. with data)</td>
<td>(64)</td>
<td>(62)</td>
<td>(68)</td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td>24.86</td>
<td>24.43</td>
<td>25.47</td>
<td>0.367</td>
</tr>
<tr>
<td>(mean±sd)</td>
<td>(±8.09)</td>
<td>(±8.73)</td>
<td>(±7.12)</td>
<td></td>
</tr>
<tr>
<td>(Min-max)</td>
<td>(3-45)</td>
<td>(3-45)</td>
<td>(4-60)</td>
<td></td>
</tr>
<tr>
<td>Heart rate (bpm)</td>
<td>40</td>
<td>40</td>
<td>40</td>
<td>0.223</td>
</tr>
<tr>
<td>Median (range)</td>
<td>36-80</td>
<td>36-80</td>
<td>36-80</td>
<td></td>
</tr>
<tr>
<td>Respiratory rate (breaths per minute)</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>0.667</td>
</tr>
<tr>
<td>Median (range)</td>
<td>15-30</td>
<td>15-30</td>
<td>16-30</td>
<td></td>
</tr>
</tbody>
</table>

Statistically significant differences between geldings (G) and females (F) indicated in bold.
females were significantly lighter, despite having a larger weight range than the geldings (Table 1; Fig 1); BCS was not significantly different between sexes. Respiratory rate counted before handling in the auscultated donkeys was 20 breaths/minute, with no difference between males and females (Table 1). Respiratory rate showed a negative association with bodyweight and a positive association with advancing age (Table 2; Fig 2a, b).

**Auscultation findings and echocardiographic assessment of heart murmurs**

The median heart rate was 40 beats per minute (bpm) (range 36–80 bpm) for the whole population, with no significant difference between the sexes (Table 1). There was a weak positive association between heart rate and respiratory rate (Table 2; Fig 2c). The predominant heart rhythm evident on auscultation was regular sinus rhythm. In three donkeys, occasional second degree atrioventricular block was identified. No donkey had a pathological arrhythmia identified. All donkeys had S1 and S2 heart sounds clearly audible. S3 was not detected in any donkey. Only nine donkeys (4.5 per cent) had an audible S4; five geldings and four females. The mean age of the donkeys with audible S4 (33.78 ± 3.90 years) was significantly older than those without (24.45 ± 8.00 years) (P < 0.001).

A heart murmur was identified in four donkeys. One 10-year-old gelding had a bilateral grade 2/6, basilar early to mid-systolic murmur, without any diastolic component. On investigation by echocardiography, this was confirmed to be due to a restrictive ventricular septal defect (VSD) (Fig 3a) associated with aortic prolapse (Fig 3b), but no significant aortic regurgitation. Peak VSD velocity recorded was 3.8 m/s, despite lack of optimal alignment with the VSD jet, suggesting preserved normal left ventricular to right ventricular pressure gradient. The other three, all geldings, aged 28 years, 29 years and 35 years, had left basilar diastolic decrescendo murmurs, graded 2/6, 3/6 and 5/6, respectively, confirmed on echocardiography to be due to aortic regurgitation (moderate in two, severe in the donkey with the grade 5/6 murmur) (Fig 4a, b). Pulse quality was considered normal in each. All three had sinus rhythm, with heart rates of 40 bpm, 40 bpm and 66 bpm, respectively. One of these donkeys, the 35-year-old with a widely radiating grade 5/6 diastolic murmur due to severe aortic regurgitation was subsequently euthanased and underwent postmortem examination, confirming aortic valve thickening (Fig 5a), consistent with degenerative valvular disease (Else and Holmes 1972a).

**Echocardiographic findings**

An additional 43 donkeys which had not had any cardiac auscultation abnormality, from the original 202 donkeys, also underwent 2D and CFDE. A total of 21.7 per cent of auscultation-normal donkeys were therefore examined. The simultaneously acquired ECG showed regular sinus rhythm in 46/47 donkeys, and 1 donkey (auscultation normal) showed occasional,
physiological, second-degree atrioventricular block. Normal 2D and CFDE examinations were recorded in 33 (76.7 per cent) donkeys. Ten donkeys (five geldings; five females) were identified to have aortic insufficiency (AoI) (23.3 per cent) in the absence of an audible diastolic heart murmur. AoI was mild in nine cases and one case had moderate AoI. Aortic valve abnormalities in a total of four cases were identified on 2D echo of those with AoI on CFDE, with aortic valve prolapse of the right coronary cusp in one mild case and aortic valve thickening and increased echogenicity in all four.

Of these 10 cases with CFDE AoI, 8 donkeys underwent subsequent postmortem examination. Two donkeys had thickened aortic valves coded at postmortem examination, which had also been noted on echocardiography (including the moderate case), but two did not.

When heart murmur-free AoI donkeys (N=10) were compared with heart murmur-free normal echo donkeys (N=33), the AoI donkeys tended to be older (median age 29 years; range 25–44 years versus median age 23 years; range 3–45 years) but this did not achieve statistical significance (P=0.107). Including the three donkeys with diastolic murmurs associated with AoI (median age 29 years), the older age of the AoI donkeys was still not statistically significant (P=0.077). There was no difference in weight (P=0.780) or heart rate (P=0.593) between the groups.

No mitral, tricuspid or pulmonic regurgitation was identified in any of the donkeys by CFDE from these right parasternal views.

**Pathology**

Out of the 202 donkeys auscultated, 76 (37.6 per cent) underwent full postmortem examination. Five had died under treatment or were found dead, and 71 had been euthanased for various reasons (Table 3), with the major reasons for death or euthanasia identified at postmortem examination being liver disease, colic or gastrointestinal conditions and respiratory diseases. In the postmortem examination population, there were 39 geldings and 37 females.

Of the 76 donkeys with postmortem data, 12 had prior echocardiography as part of this study. The echocardiography was normal in 3 and showed AoI in 9 out of the 12 (1 severe, 1 moderate and 7 mild cases). Postmortem coding of ‘thickened aortic valve’ was only reported in three of these cases (one severe...
(Fig 5b), one moderate and one mild case). Aortic valve thickening was not reported in the three echocardiographically normal cases, but one 40-year-old gelding (Fig 6a) from the echo-normal group had nodular lesions within the proximal aorta including the sinus of Valsalva and sinus aspect of the aortic valves themselves (Fig 6b, c).

Histopathology was obtained from these lesions (Fig 7a–c), which showed multifocal chronic nodular eosinophilic arteritis with chronic intimal fibrosis (arteriosclerosis) and intralesional mineralisation consistent with chronic degenerative disease of the intima. Although parasites were not evident in the sections, the lesions were most suggestive of chronic arteriosclerotic plaques described in other species (including horses) due to verminous arteritis (Else and Holmes 1972a). No gross myocardial lesions were identified, but systematic myocardial histopathology was not carried out.

From the full pathology archive from postmortem examinations carried out at the DS, the total number of postmortems and the number of donkeys identified with ‘cardiac lesions’ as a major code are noted by year (2006–2010) in Table 4. These were either valvular or vascular; myocardial lesions were not coded as a major finding in these numbers. Similar nodular lesions within the proximal aorta as described above were reported.

**Table 3**

<table>
<thead>
<tr>
<th>Major postmortem finding or cause of death</th>
<th>No. of cases</th>
<th>Major postmortem finding or cause of death</th>
<th>No. of cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiac</td>
<td>1 (1.3%)</td>
<td>Laminitis/feet</td>
<td>4 (5.3%)</td>
</tr>
<tr>
<td>Vascular</td>
<td>1 (1.3%)</td>
<td>Arthritis</td>
<td>7 (9.2%)</td>
</tr>
<tr>
<td>Respiratory</td>
<td>13 (17.1%)</td>
<td>Neurological</td>
<td>3 (3.9%)</td>
</tr>
<tr>
<td>Hepatopathy</td>
<td>15 (19.7%)</td>
<td>Collapse</td>
<td>1 (1.3%)</td>
</tr>
<tr>
<td>Colic/gastrointestinal</td>
<td>14 (18.4%)</td>
<td>Weight loss</td>
<td>3 (3.9%)</td>
</tr>
<tr>
<td>Dental</td>
<td>4 (5.3%)</td>
<td>Dull/anorexic</td>
<td>7 (9.2%)</td>
</tr>
<tr>
<td>Hyperlipidaemia</td>
<td>2 (2.6%)</td>
<td>Other (ovarian torsion as cause of collapse)</td>
<td></td>
</tr>
</tbody>
</table>

**Discussion**

This study identified a low prevalence of clinically important cardiac disease across a wide age range in this representative subset of the UK donkey population (estimated to be five to six per cent of the total cared for by the DS). Both echocardiography and postmortem examination identified degenerative valvular disease, particularly affecting the aortic valve, similar to horses. This tended to be in older donkeys although this did not achieve statistical significance, likely due to low numbers.

The physical examination findings, in particular heart rate and respiratory rate, are in accordance with other publications from healthy, non-working (Delvaux and others 2001, Svendsen 2008) and working (Ayo and others 2008) donkeys. Sinus arrhythmia was not identified in any donkey in the present study, in contrast to 59 per cent of donkeys (2–18 years old) reported by Delvaux and others (2001). Second-degree atrioventricular block was documented in 3 donkeys, but not reported in any of the 22 in the Delvaux and others’ (2001) study. The association between heart rate and respiratory rate may merely reflect stress level. The association between respiratory rate and advancing age may reflect concurrent respiratory disease such as pulmonary fibrosis (Thiemann 2012).

S4 was detected in nine donkeys, which were significantly older than donkeys without an audible S4. This is consistent with the findings in human beings, where S4 is reported in a total of 15.6 per cent healthy subjects, but increasing age increased the odds of S4 being detected (Collins and others 2005). With ageing in human patients, the left ventricle is less able to relax and ventricular filling is more dependent on atrial contraction, which may explain this finding (Lewis and Maron 1992). Detection of the transient S3 and S4 sounds is common in horses, but less common in ponies (Blissitt 2010). S3 was not detected in any donkey in this study. The presence of S3 and S4 was not commented on in other studies in donkeys (Delvaux and others 2001, Amory and others 2004, Svendsen 2005).

In this population, only four donkeys had murmurs identified on cardiac auscultation (2.0 per cent). One of these was identified with a VSD. This is a fairly common congenital heart defect in foals and adult horses and ponies (Reef 1995, Marr 1999, 2010a, Hall and others 2010). The authors are unaware of published case reports about VSD in donkeys.
In three aged donkeys (1.5 per cent), aortic insufficiency was identified by presence of a heart murmur, confirmed by Doppler echocardiography and, in one, confirmed as being associated with degenerative valvular disease on postmortem examination. The prevalence is slightly less than that reported for older horses (Patteson and Cripps 1993, Marr 2010b), but the pathology in donkeys (Morrow and others 2011) is similar to that described for horses (Else and Holmes 1972a). None of the donkeys had other clinical signs consistent with haemodynamically significant aortic regurgitation (Reef and others 2014).

Heart murmurs appeared to be much less common than in horses (Patteson and Cripps 1995), but when present, in the four donkeys here, the murmur did reflect the presence of structural cardiac disease. Of particular note is that the authors did not identify the ejection or flow murmurs recognised frequently in thoroughbred horses (Patteson and Cripps 1995, Kriz and others 2000). This may be related to the sedentary lifestyle of donkeys at the DS compared with athletic horses. This is in contrast to the ejection-type murmurs identified in 9/22 (41 per cent) of donkeys in another study (Amory and others 2004). Heart murmurs were not mentioned in another echocardiography study of working donkeys (Hassan and Torad 2015). In geriatric horses, the 20 per cent prevalence of heart murmurs (Ireland and others 2012), is much higher than this study. Three of the four donkeys with a heart murmur were less than the median weight of the gelding population (Table 1; weighing 142 kg, 148 kg and 156 kg, respectively; the heaviest weighed 184 kg). Speculatively, murmurs may be less likely to be detected in overweight donkeys, and those with thick hair coats.

CFDE identified AoI without an audible diastolic heart murmur, confirming its superior sensitivity over auscultation (Blissitt and Bonagura 1995). Of note, no mitral, tricuspid or pulmonic regurgitation was identified in this study. Valvular incompetence in donkeys may be much less prevalent than in horses (Blissitt and Bonagura 1995, Kriz and others 2000, Marr 2010b). However, CFDE was only carried out from right parasternal views, and if also carried out from the left hemithorax, it is possible that more valvular incompetence would have been identified.

Only 12 donkeys underwent both echocardiography and postmortem examination. For the three echo-normal cases, no aortic valvular pathology was noted. However, nine donkeys had AoI identified on echocardiography, but only in the severe, the moderate and in one out of the seven mild cases classified by echocardiography, was gross aortic valve thickening documented at postmortem examination. This indicates that there may be functional aortic regurgitation before any gross pathology, as reported in horses (Blissitt and Bonagura 1995, Marr 2010b).

The retrieved postmortem records of the donkeys from this study were very brief, and some referred to more than one body system affected by pathology, but only the major finding was recorded in Table 3. Liver disease, gastrointestinal disease and respiratory conditions were most frequent in this group of donkeys, and were also identified as being significant in another postmortem survey from the DS (Morrow and others 2011). Often, euthanasia decisions were based on multiple comorbidities affecting quality of life of each donkey. Unfortunately, the authors only had brief coding records of the cause of death and postmortem examination findings, which likely led to some
**TABLE 4: Numbers of donkeys identified with ‘cardiac lesions’ as a major code by year compared with numbers of deaths and numbers of postmortem examinations (reproduced with permission of The Donkey Sanctuary)**

<table>
<thead>
<tr>
<th>Year</th>
<th>Total died</th>
<th>Total postmortem examinations</th>
<th>Cardiac lesions identified</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>390</td>
<td>305</td>
<td>209 (68%)</td>
</tr>
<tr>
<td>2007</td>
<td>393</td>
<td>289</td>
<td>227 (78%)</td>
</tr>
<tr>
<td>2009</td>
<td>381</td>
<td>303</td>
<td>224 (73%)</td>
</tr>
<tr>
<td>2009</td>
<td>394</td>
<td>294</td>
<td>214 (72%)</td>
</tr>
<tr>
<td>2010</td>
<td>395</td>
<td>260</td>
<td>188 (70%)</td>
</tr>
<tr>
<td>TOTAL</td>
<td>1953</td>
<td>1451</td>
<td>1058 (73%)</td>
</tr>
</tbody>
</table>

The differences between this report and the study of Morrow and others (2011). Vascular lesions were commonly identified in the Morrow and others (2011) study but was only coded in one case in the present study. Similarly, only one case had cardiac disease listed as the most important postmortem finding in the present study (the case with severe aortic regurgitation) although aortic valve thickening was recorded in a total of four donkeys (9.2 per cent). The severe aortic regurgitation case, and the single case where vascular disease was coded as the major postmortem examination finding (the 40-year-old with proximal aortic nodular lesions) were euthanased due to other quality of life issues, including laminitis, arthritis and reduced appetite rather than their cardiovascular conditions. Morrow and others (2011) reported a prevalence of 53 per cent with valvular disease. The differences are likely due to differing goals. In the present study, the authors only retrieved the pathology major codes and cause of death, and did not retrieve details of the postmortem examination findings, but the goal of Morrow and others (2011) was to categorise all the conditions identified at postmortem examination.

The raised granulomatous lesions identified in the proximal aorta in one case in this study, and from more donkeys from the archive were thought to reflect verminous arteritis by the pathologist’s report, even though no parasites were identified. Similar lesions were also described by Morrow and others (2011), although their cause was not attributed to prior parasitism such as *Strongylus vulgaris* infestation. There was a strong association between vascular lesions and aneurysm, particularly of the cranial mesenteric artery, speculated to be associated with ageing, possibly because endoparasites were apparently uncommon in that study (Morrow and others 2011). The location, gross pathology and histopathology findings are strikingly similar to those described in horses (Else and Holmes 1972a, b), associated with previous *Strongylus vulgaris* migration, as also shown with experimental infestation (Duncan and Pirie 1975). There is also a strong association described between strongylosis and myocardial lesions (Cranley and McCullagh 1981). *Strongylus vulgaris* affects donkeys, including the cranial mesenteric artery (Tolliver and others 1985, Asefa and others 2011). However, to the authors’ knowledge, the association of the proximal aortic nodular lesions and strongylosis has not previously been documented in donkeys, despite evidence in horses (Else and Holmes 1972a).

The percentage of donkeys recorded in the pathology archive over each year with ‘cardiac lesions’ as a major code was very high (approximately 70 per cent per year). However, this includes any cardiovascular pathology, including the vascular lesions (arteriosclerosis, aortic lesions, aneurysms) as well as valvular and myocardial lesions, so these data are likely similar to those of Morrow and others (2011). That study ranged from 2001 to 2008, so there will be overlap between the two studies. In the data presented here, any cardiac or vascular lesion considered to be minor would not have been retrieved, and vascular lesions more peripheral than the proximal aorta would also not...
have been included, and so the numbers in Table 4 likely underrepresent the frequency of these findings.

The questionnaire showed that this small group of veterinary surgeons had very little experience with pet donkeys, with only 25/35 vets examining this species and the maximum number of donkeys seen per year by one vet was 35, but the respondents saw a median of 3 donkeys a year. Despite this, a minority of vets considered that clinically detectable heart disease may be a problem in the species, ranging from 30 per cent (vets not examining donkeys) to 40 per cent (vets examining donkeys). In fact, the vets examining more donkeys (average 7.9/vet) were less likely to consider that heart disease was significant than those examining fewer donkeys (average 5.9/vet). Only one out of a total of 176 donkeys examined was identified with a heart murmur and none were treated for cardiac disease. These results are intriguing, as they show most vets expect a much higher frequency of clinically detectable heart disease than was actually diagnosed, or that the authors identified in the DS population of donkeys. The survey of vets also confirms the dearth of veterinary literature about cardiac disease in donkeys, or lack of knowledge of sources of information. Three vets cited the Professional Handbook of the Donkey (Swenden 2008) as their primary reference, but clinical heart disease is not mentioned in this text, although aortic valvar pathology is described.

There are a number of limitations to this study. Only one observer carried out the auscultation and echocardiography, therefore interobserver agreement or variation could not be determined. Auscultation and the detection of quiet heart murmurs can be affected by a number of factors, including environmental noise (minimised as far as possible), stethoscope quality and hearing acuity. Donkeys have thicker skin and hair coat than horses, tended to have increased fat, and also have a thicker cutaneous colli muscle and which may make auscultation less rewarding than in horses. It is therefore certainly possible that quieter murmurs could be missed. In addition, the donkey with a restrictive VSD, expected to have a loud right-sided systolic heart murmur, only had a grade 2/6 murmur noted, which supports the ‘muffling’ effects of the chest wall on auscultation.

Echocardiography only included the right-sided views to identify CFDE evidence of valvular regurgitations, and the left-sided views may have added greater sensitivity. Only a small proportion of the donkeys which underwent echocardiography had postmortem examination, and the authors could not provide gross pathology and echocardiography images from many of the sample cases, as pathology photographs were not routinely obtained. Finally, review of the pathology archive was dependent on the major coding applied at that time of postmortem examination, so lesions considered less significant or minor would not have been retrieved. This likely explains differences between this study and the systematic categorisation of all pathological lesions by Morrow and others (2011).

Conclusions

This cross-sectional study shows that donkeys may be affected by congenital and acquired degenerative valvar disease, but no donkey in this study showed significant cardiac remodelling or clinically relevant disease. Heart murmurs reflect structural heart disease. Peripheral vascular disease, with intimal nodular lesions, can affect the proximal aorta, thought to reflect prior and probably extinct strongylo infection.

Acknowledgements

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Assessment of cardiovascular disease in the donkey: clinical, echocardiographic and pathological observations
S. L. Roberts and J. Dukes-McEwan

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