

# Laryngeal paralysis: a study of 375 cases in a mixed-breed population of horses

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## Summary

**Referred cases (n = 375) of laryngeal paralysis (1985–1998) from a mixed-breed equine population included 351 (94%) cases of recurrent laryngeal neuropathy (RLN) (idiopathic laryngeal hemiplegia) and 24 cases (6%) of laryngeal paralysis from causes other than RLN. Laryngeal movements were classified endoscopically into one of 6 grades, in contrast to the usual 4 grades. The RLN cases had a median grade 4 laryngeal paralysis, of which 96% were left-sided, 2% right-sided and 2% bilaterally affected. RLN cases included 204 (58%) Thoroughbred, 96 (27%) Thoroughbred-cross, 23 (7%) draught, 16 (5%) Warmbloods and 10 (3%) other breeds, including only 4 (1%) ponies. The median age of RLN cases at referral was 6 years (range 2–12) and their median height was 170.2 cm. The work of RLN horses included National Hunt racing (42%), flat racing (1%), hunting (19%), eventing (16%) and miscellaneous work (22%). Reported presenting signs in RLN-affected horses included abnormal exercise-related respiratory sounds in 90% and reduced exercise tolerance in only 64%. However, many horses were referred before their exercise tolerance could be fully assessed. Forty percent of the RLN cases had intercurrent disorders, including 10% with additional upper respiratory and 7% with lower respiratory tract diseases. The 24 nonidiopathic RLN cases included 12 with bilateral laryngeal paralysis, 11 (92%) of which were ponies. Bilateral laryngeal paralysis occurred with hepatic encephalopathy in 7 cases and following general anaesthesia in 2 cases. The 12 cases of acquired unilateral laryngeal paralysis included 7 caused by guttural pouch mycosis.**

## Introduction

Laryngeal paralysis (and paresis, i.e. partial paralysis, included together in this paper for brevity) has long been recognised as an important and incurable disease of horses (Fleming 1889; Cadiot 1892). The most common type of equine laryngeal paralysis, termed recurrent laryngeal neuropathy (RLN) or idiopathic laryngeal hemiplegia (ILH), is caused by a distal degeneration of the recurrent laryngeal nerve of unknown aetiology. RLN most

commonly affects larger horses, usually the left side of the larynx and, less frequently, the right side or bilaterally (Marks *et al.* 1970; Duncan and Brook 1985). Numerous studies have described the pathology (Gunn 1973; Duncan *et al.* 1978, 1991), pathogenesis (Cahill and Goulden 1987), diagnosis (Ducharme *et al.* 1991; Hackett *et al.* 1991), clinical findings (Goulden and Anderson 1981a,b), physiological responses (Christley *et al.* 1997) and treatment (Marks *et al.* 1970). Extensive reviews include those by Robertson (1991), Spiers *et al.* (1992), Lane (1993) and Anderson *et al.* (1997). Much of the literature suggests that RLN is primarily a disease of young Thoroughbreds (Marks *et al.* 1970; Cook 1970; Robertson 1991) and it remains unclear whether the disease is congenital or progressive (Lane 1993).

In addition to RLN, damage to the recurrent laryngeal nerve from other disorders, such as guttural pouch mycosis, perivascular irritant drug injections in the cervical area, neck trauma and neoplasia (Gilbert 1972; Cook 1970) can result in unilateral and usually sudden-onset, complete laryngeal paralysis (i.e. hemiplegia). Bilateral laryngeal paralysis has been recorded in horses following organophosphate poisoning (Rose *et al.* 1981; Duncan and Brook 1985), hepatic encephalopathy (Mayhew 1989; Dixon 1993; McGorum *et al.* 1999) and following general anaesthesia (Dixon *et al.* 1993). Goulden and Anderson (1981b) found that 11% of 140 cases of laryngeal paralysis were caused by disorders other than RLN.

Despite numerous reports, few long-term studies have been performed, particularly in a mixed-breed equine population. Our purpose was to examine both retrospectively (154 cases) and prospectively (221 cases) the clinical and ancillary diagnostic details and the possible causes of 375 consecutive cases of laryngeal paralysis from a mixed-breed, working population of primarily mature horses over a 13 year period, and to highlight the differences between the current findings and those commonly reported in the literature.

## Materials and methods

The records of 375 consecutive cases of laryngeal paralysis referred to the senior author at the Large Animal Hospital of The University of Edinburgh 1985–1998 were reviewed. Most cases comprised National Hunt TB racehorses, hunters and eventers with working careers of up to 10 years, usually with the same trainer or owner, thereby facilitating a long-term study. For 59 (16%) of these horses, long-term records of upper respiratory tract

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**TABLE 1: Endoscopic criteria for grading equine laryngeal paralysis**

<i>Grade 0</i>	Perfect synchrony and symmetry of the larynx with full bilateral abduction achieved and maintained.
<i>Grade 1</i>	Shivering and/or asynchrony of the arytenoid (usually left-sided) present, but full bilateral abduction achieved and maintained.
<i>Grade 2</i>	Slight lack of abduction, especially during attempted full abduction (slight asymmetry of larynx present if lesion unilateral).
<i>Grade 3</i>	Moderate lack of abduction, especially during attempted full abduction (moderate asymmetry of larynx present if lesion unilateral).
<i>Grade 4</i>	Marked (but not total) lack of abduction at rest and attempted full abduction (marked asymmetry of larynx present if lesion unilateral).
<i>Grade 5</i>	Total lack of abduction at all times (marked asymmetry of larynx always present if lesion unilateral).

endoscopy (performed mainly at this hospital) were available prior to referral because of suspected laryngeal paralysis. Therefore, it was also possible to study long-term clinical and endoscopic laryngeal findings in some cases and, consequently, to examine for possible longer-term variation in the clinical and endoscopic severity of this disease (Dixon *et al.* 2001).

In this study, all laryngeal movement dysfunction (unilateral or bilateral) of unknown aetiology was classified as RLN. Horses that had not been measured for height (to withers) prior to referral were measured on a level surface (making an allowance for shoes if necessary). All endoscopic evaluations were performed without sedation. Endoscopic grading of laryngeal paralysis was assessed at rest, prior to and following nasal occlusion and transendoscopic nasopharyngeal flushing with water. For reasons discussed later, a 6 grade system for assessing laryngeal function was utilised (Table 1). Whenever possible, endoscopy was repeated after appropriate fast work.

Treadmill endoscopy was only available towards the end of this study and just 6 of these RLN cases had such examinations.

Full clinical histories, in particular details of possible abnormal exercise-related respiratory sounds ('noises') or of reduced exercise performance, were documented. A complete physical examination, including a specific examination for intercurrent respiratory disease, was performed in all cases and included laryngeal muscle palpation and resting upper and lower respiratory tract endoscopy. Where possible, horses were evaluated clinically during ridden or lungeing exercise, in particular for the presence of 'noises'. As data were not normally distributed, they are presented as median and range. All statistical analyses were performed using nonparametric techniques, i.e. Kruskal-Wallis one-way analysis of variance and Mann-Whitney U tests.

## Results

### *Recurrent laryngeal neuropathy*

Three hundred and fifty-one of the 375 cases (94%) of laryngeal paralysis were diagnosed as suffering from RLN. The other 24 cases (6%) were diagnosed as suffering from other forms of unilateral or bilateral laryngeal paralysis and are described later. The RLN cases included 337 (96%) left-sided, 7 (2%) right-sided and 7 (2%) bilateral cases (Table 2). Reasons for referral of the 351 RLN cases included the presence of abnormal exercise-related respiratory 'noises' in 316 cases (90%), with these 'noises' being detected at prepurchase examinations in 19 (5%) of these cases. No such 'noises' were reported (although later were found to be present in some) in the 35 cases of RLN that were primarily referred for investigation of poor exercise performance.

Following referral, all horses had clinical and resting endoscopic examinations. Additionally, examinations during ridden or lungeing exercise and immediate postexercise endoscopy were performed in 226 (64%) and treadmill endoscopy in 6 (2%) of the 351 RLN cases. Laryngeal paralysis was considered so severe in 97 (28%) cases that examinations at

**TABLE 2: Historical, clinical, endoscopic and workload details of 351 cases of recurrent laryngeal neuropathy (RLN)**

Case data	Overall	TB	TB cross-breeds	Draught	Warmblood	Other breeds
No. cases	351	204	96	23	18	10
Age (years); median (range)	6 (2–16)	6 (2–14)	7 (3–15)	5 (2–16)	6 (4–12)	7 (3–15)
Females	62	36	19	1	3	3
Geldings	284	164	77	22	15	6
Males	5	4	0	0	0	1
Height (cm); median (range)	170.2 (121.9–188.0)	167.6 (157.5–182.9)	170.2 (157.5–182.9)	180.3 (172.7–188.0)	172.7 (162.6–182.9)	157.5 (121.9–170.2)
Left paralysis	337 (96%)	194 (95%)	93 (96.9%)	23 (100%)	18 (100%)	9 (90%)
Right paralysis	7 (2%)	5 (3%)	1 (1%)	0	0	1 (10%)
Bilateral paralysis	7 (2%)	5 (3%)	2 (2.1%)	0	0	0
Grade of RLN; median (range)	4 (2–5)	3 (2–5)	4 (2–5)	5 (2–5)	5 (2–5)	3 (2–5)
Type of work						
Flat racing	5 (1%)	5 (3%)	0	0	0	0
National Hunt racing	148 (42%)	148 (73%)	0	0	0	0
Hunting	65 (19%)	14 (7%)	46 (48%)	2 (9%)	3 (17%)	0
Eventing	56 (16%)	18 (9%)	31 (32%)	1 (4%)	5 (28%)	1 (10%)
Showjumping	17 (5%)	4 (2%)	5 (5%)	2 (9%)	4 (22%)	2 (20%)
Driving	17 (4.8%)	0	0	17 (73.9%)	0	0
Hacking/other	43 (12%)	15 (7%)	14 (15%)	1 (4%)	6 (33%)	7 (70%)

**TABLE 3: Details of 12 cases of bilateral laryngeal paralysis not caused by recurrent laryngeal neuropathy**

Case No.	Aetiology clinical details	Age (years)	Sex	Breed	Lar. par. grade Left/right	Treatment	Outcome
1	After general anaesthesia	3	MN	Pony	Temp. 4/4	None	Recovered in 24 h
2	After general anaesthesia and postoperative myositis	8	F	Pony	Temp. 5/5 Residual 0/3	Temp. tracheostomy	In full work, 'noises' only at maximal work
3	Unknown, other CNS signs Slight 'noises' for 12 m, then acute stridor at rest	13	MN	Pony	5/5	Initially (L) LP and VC Temp. tracheostomy, (R) LP	Sudden death 1 week after final treatment
4	Unknown. Concurrent cricopharyngeal-laryngeal dysplasia	6	F	Pony	Temp. 5/3 Residual 5/0	Prior bilateral HD, Later (L) LP and arytenoidectomy	Returned to full work, some residual 'noises'
5	Unknown. Acute dyspnoea and pulmonary haemorrhage	16	F	Pony	Temp. 4/4	None	Returned to full work
6	Hepatic encephalopathy.	11	F	Pony	Temp. 5/5	None	Returned to full work
7	Hepatic encephalopathy	7	MN	Pony	5/5	None	Euthanasia
8	Hepatic encephalopathy	16	F	Pony	5/5	None	Euthanasia
9	Hepatic encephalopathy	13	F	Pony	5/5	Temp. tracheostomy	Euthanasia
10	Hepatic encephalopathy	14	MN	TBx	5/5	None	Euthanasia
11	Hepatic encephalopathy	14	MN	Pony	Temporary 5/5	None	Euthanasia
12	Hepatic encephalopathy	8	M	Pony	5/5	Temp. tracheostomy	Euthanasia

Lar. par. = laryngeal paralysis; TBx = Thoroughbred-cross; Temp. = Temporary; HD = Hobday operation (ventriculectomy); VC = vocalcordectomy; LP = laryngoplasty; F = female; M = male; MN = gelding.

exercise were not deemed necessary. In the remaining 22 horses (6%), intercurrent lameness or other disorders, or inclement weather, precluded examinations during exercise.

Many owners and trainers had difficulty describing the nature of the reported 'noises', in particular, differentiating between inspiratory and expiratory sounds. In some cases, riders had passed on the details of such 'noises' to them. These 'noises' were reported to be primarily inspiratory in 211 cases (67%), biphasic in 33 cases (10%), expiratory in 2 cases (1%) and of an uncertain nature in 70 cases (22%). The 'noises' were reported to occur at rest in one, to occur initially at the walk in 11 cases (4%), at the trot in 56 cases (18%), at the canter in 79 cases (25%), at the gallop in 108 cases (34%) and at an uncertain stage of exercise in 62 cases (20%).

In the 316 cases that that made 'noises', the onset of such 'noises' was considered not to be associated with reduced exercise performance in 16 (5%) cases, to be associated with slightly impaired exercise performance in 32 cases (10%) and with greatly impaired exercise performance in 156 cases (49%). The trainers/owners were unsure of any relationship between the recorded abnormal 'noises' and exercise performance in 112 cases (35%). This latter group comprised mainly horses with endoscopic *grade 4* or *5* RLN which made loud 'noises' at low intensity exercise or the start of training and which were subsequently taken out of work for investigation before any assessment of associated impaired exercise tolerance could be made. As previously noted, 35 horses were referred primarily because of poor exercise performance, without any 'noises' being detected, making a total of 223 cases (64%) with reported poor exercise performance.

The median age of RLN cases at initial presentation to this clinic was 6 (range 2–16) years (Table 2). No significant age difference was observed between breeds with median 5 years for draught horses to 7 years for Thoroughbred-crosses (Table 2). Affected horses were predominantly male, including 284 (81%) geldings, 5 (1%) entire males and 62 (18%) females. The disease

predominantly affected taller horses, with an overall median height of affected animals of 170.2 cm (range 121.9–188.0 cm) with draught horses (median 177.8 cm) and Warmbloods (median 172.7 cm) being the tallest breeds. Consequently, Thoroughbred-cross horses (usually crossed with Irish draught) at median 170.2 cm were slightly taller than Thoroughbreds (median 167.6 cm).

The overall median endoscopic grade of laryngeal paralysis was *grade 4* (range 2–5). The Thoroughbreds (median *grade 3*, range 2–5) had less severe (statistically nonsignificant) RLN than TB-crosses (median *grade 4*, range 2–5) and even more so (but also statistically nonsignificant) than the draught or Warmblood horses (both median *grade 5*, range 2–5). The work of RLN-affected horses was largely breed-dependent, with 153 (75%) of the 204 Thoroughbreds used for racing, predominantly (72.6%) National Hunt racing, with just 2.5% used for flat racing (Table 2). In contrast, 80% of the Thoroughbred-crosses and 45% of the Warmbloods were used for hunting or eventing. Eighteen of the 23 draught horses were Clydesdales used for show driving and the remaining 5 (Irish Draught) were hunters or showjumpers.

The miscellaneous breeds included 4 ponies (median age 8.5 years, median height 121.9 cm, range 121.9–147.3 cm), all with left-sided hemiparesis (median *grade 3.5*, range 2–4). It is possible that an undetected intermittent bilateral paralysis was present in one of these ponies, which was reported occasionally to suffer stridor at rest. The miscellaneous breeds also included 2 Standardbreds (mean age 3 years, mean height 154.9 cm), one with left-sided (*grade 4*) and one with right-sided (*grade 2*) RLN. Evidence of progression of the degree of laryngeal paralysis in 52 (15%) of these 351 RLN cases is presented by Dixon *et al.* (2001).

Surgical treatment had been performed on 36 (10%) RLN cases prior to referral, including unilateral ventriculectomy (14 cases), unilateral ventriculectomy and cordectomy (1), bilateral ventriculectomy (7), laryngoplasty and ventriculectomy (5), ventriculectomy and, at a later stage,

**TABLE 4: Details of 12 horses with unilateral laryngeal paralysis not caused by recurrent laryngeal neuropathy**

Case	Aetiology	Age (years)	Sex	Breed	Grade Lar. par.	Treatment	Outcome
1	Undiagnosed CNS disorder. L. pharyngeal, facial and lar. par.	7	F	TB	4	None	Retired
2	Perivascular flunixin injection - L. lar. par. and cervical sympathetic trunk damage	4	MN	TBx	5	LP, HD and VC	Returned to full athletic (3-day eventing) work
3	Mediastinal lymphosarcoma and L. lar. par.	8	F	Pony	5	Temp. tracheostomy	Euthanasia
4	Iatrogenic? L. lar. par. had oesophageal surgery	2	MN	TB	4	LP, HD and VC	No Horner's syndrome? Went on to full work
5	Thyroid carcinoma: L. lar. par.	18	F	ID	5	None	Euthanasia
6	GPM: R. lar. and facial par.	4	MN	TBx	3	Local antimycotics	Laryngeal paralysis resolved
7	GPM: R. lar. and pharyngeal dysphagia	13	F	TBx	5	Local antimycotics	Euthanasia because of dysphagia
8	GPM: L. lar. par. and partial pharyngeal dysphagia	7	F	TB	5	Local antimycotics LP, HD and VC	Dysphagia resolved. Returned to racing
9	GPM: R. lar. par., Horner's syndrome	8	MN	Pony	5	Local antimycotics	Returned to full work
10	GPM: L. lar. and pharyngeal par.	13	F	TBx	5	Local antimycotics	Euthanasia because of dysphagia
11	GPM: L. lar. par. and dysphagia	7	F	TB	5	Local antimycotics LP, HD and VC	Dysphagia resolved. Returned to racing
12	GPM: R. lar. and pharyngeal par. Int. carotid haemorrhage	5	F	Pony	4	Int. carotid ligation Local antimycotics	Severe postanaesthetic myopathy - euthanasia

Lar = laryngeal; Par = paralysis; GPM = guttural pouch mycosis; TB = Thoroughbred; TBx = Thoroughbred cross; ID = Irish draught; HD = Hobday operation (ventriculectomy); VC = vocalcordectomy; LP = laryngoplasty; L = left; R = right; F = female; MN = gelding.

tracheostomy (7), and tracheostomy (2).

Intercurrent disorders were recorded in 141 (40%) of these 351 cases, with 2 or more intercurrent disorders diagnosed in 39 (11%) cases. Intercurrent respiratory tract disorders were diagnosed in 59 cases (17%) that undoubtedly contributed to the reported respiratory signs in some of these cases. These included 23 horses (7%) with intercurrent pulmonary disorders, including chronic obstructive pulmonary disease, severe exercise-induced pulmonary haemorrhage or idiopathic chronic pulmonary diseases (Dixon *et al.* 1995).

Thirty-six cases (10%) had intercurrent upper respiratory tract disorders including 16 cases of exercise-related dynamic nasopharyngeal obstruction, as diagnosed by clinical history alone in 13 horses and by treadmill endoscopy in 3 cases (dorsal displacement of the soft palate in the latter 3). Five cases had cricopharyngeal-laryngeal dysplasia (rostral displacement of the palatopharyngeal arch), 3 had large nasopharyngeal lymphoid polyps and 2 had chronic rhinitis of unknown origin. Single cases of partial, unilateral nasal paralysis, false nostril cyst, vasomotor rhinitis, nasopharyngeal collapse, epiglottic deformity, arytenoid chondritis, vocal fold deformity (apparently nonsurgical), laryngeal polyp, grossly enlarged cricotracheal ligament and gross lateral tracheal deformity ('scabbard trachea') were also diagnosed. Care was taken to ensure that these intercurrent disorders, especially laryngeal disorders such as cricopharyngeal-laryngeal dysplasia, arytenoid chondritis or vocal fold deformity, that could be misdiagnosed as RLN, were in fact additional laryngeal disorders to the RLN. The intercurrent disorders in the remaining horses included orthopaedic disorders in 44 cases and cardiac, gastrointestinal, dental and dermatological disorders in the remaining 38.

#### *Bilateral non-RLN laryngeal paralysis*

Twelve cases (median age 12 years, range 3–16 years; median height 144.8 cm, 137.2–152.4 cm), including 11 ponies and one Thoroughbred-cross, were diagnosed as having bilateral laryngeal paralysis not believed to be caused by RLN (Table 3). In 7 of these cases (Cases 6–12), the bilateral laryngeal dysfunction was associated with hepatic encephalopathy caused by acquired hepatic disease, which was usually attributed to pyrrolizidine alkaloids poisoning in these cases. This type of laryngeal dysfunction was episodic, with clinical and endoscopic evidence of laryngeal paralysis often worsening during exacerbations of encephalopathy. The laryngeal dysfunction resolved in 2 of these cases that recovered, but one of these had a relapse over a year later (Table 3).

Bilateral laryngeal paralysis developed following general anaesthesia in 2 cases, fully resolving in one case (Case 1) and partially resolving in the other (Case 2) (Dixon *et al.* 1993). A temporary bilateral laryngeal paralysis of unknown aetiology was recognised in 2 ponies (Cases 4 and 5), which had no clinical or biochemical evidence of hepatic disease and which had not recently undergone anaesthesia. Permanent bilateral laryngeal paralysis of unknown aetiology was detected in a further case (Case 3). Bilateral laryngeal paralysis (unlike unilateral laryngeal paralysis) often caused severe dyspnoea, even at rest. Six of these 12 cases showed severe dyspnoea, stridor and sometimes cyanosis, with 4 requiring an emergency temporary tracheostomy.

#### *Unilateral non-RLN paralysis*

Twelve cases (median age 7 years, range 2–18; median height

157.5 cm, range 144.8–170.2 cm) were diagnosed as having non-RLN unilateral laryngeal paralysis (median *grade 4*, range 3–5) (Table 4), including 7 cases with guttural pouch mycosis (5 right-sided and 2 left-sided). Unexpectedly, a *grade 3* laryngeal paralysis in one guttural pouch mycosis case (*Case 6*) resolved fully within months following topical natamycin therapy. In single cases, unilateral laryngeal paralysis was associated with a perivascular flunixin meglumine injection, thyroid carcinoma, thymic lymphosarcoma and with multiple unilateral cranial nerve defects of unknown aetiology. One case was diagnosed as suffering from left laryngeal paralysis following surgical repair of an oesophageal diverticulum; however, as no cervical or cranial sympathetic trunk damage was apparent, this laryngeal paralysis may not have been related to the surgery, but due to RLN.

## Discussion

A number of semiquantitative grading systems have been utilised to assess the endoscopic changes present in equine laryngeal paralysis, including the widely used 4-grade system of Ducharme *et al.* (1989) and Hackett *et al.* (1991). However, in the authors' opinion, further subdivision is required in the grade of laryngeal paralysis that describes hemiparesis (partial unilateral paralysis of the larynx), i.e. *grade 3* RLN according to Ducharme *et al.* (1989). This grade lies between these authors' *grade 2* RLN, which describes asynchrony and/or shivering of the larynx accompanied by full abduction, and their *grade 4*, which describes complete laryngeal paralysis (hemiplegia when unilateral). This is because these authors' *grade 3* paralysis could include horses that showed a constant, but slight, laryngeal asymmetry (often observed only during attempted maximal arytenoid abduction) that appears to be clinically insignificant in some horses. However, it also included those with marked laryngeal hemiparesis, bordering on total laryngeal paralysis, with just minimal laryngeal movements remaining. The grouping together of such a wide range of laryngeal dysfunction does not appear optimal.

The endoscopic grading system of Lane (1993) which used 2 separate grades (*grades 3* and *4*) to describe anomalous laryngeal movements and symmetry, equivalent to *grade 3* according to Ducharme *et al.* (1989), offers increased flexibility. However, in the current study, 3 grades were utilised to subdivide this range of anomalous laryngeal movements (Table 1). Similarly, Embertson (1997) also subdivided the (resting) endoscopic grades of RLN that describe asymmetric movements into 2 grades. Hammer *et al.* (1998) subdivided this same grade, as assessed during high-speed treadmill exercise, into 3 grades.

Embertson (1997) suggested that horses with at least 90% arytenoid abduction at rest that could be maintained should be considered normal, as should yearlings which cannot be induced to achieve full abduction of both left and right arytenoids at rest, if at least moderate abduction occurs and arytenoid movements are synchronous and symmetrical. Morris and Seeherman (1990), Rakestraw *et al.* (1991) and Christley *et al.* (1997) similarly found that many horses with laryngeal asynchrony and asymmetry at rest had normal laryngeal function during treadmill exercise. However, Hammer *et al.* (1998) argued that if treadmill exercise had been more strenuous in the 2 earlier studies, then abnormal laryngeal function might have been detected in some of these cases, a feature recorded by Christley *et al.* (1997). The relationship between endoscopic findings at

rest and during strenuous high-speed treadmill exercise requires some further clarification.

As previously noted, the type of work which the RLN-affected horses undertook was largely breed-related, with most (75%) of the TBs involved in racing. Consequently, lesser degrees of RLN might be expected to cause a recognisable problem in this group, where the median grade RLN was *grade 3*. This is in contrast to the draught horses (median *grade 5* RLN), most of which were used for less strenuous show driving. Consequently, most draught horses were not referred for examination unless they had total (unilateral) RLN. Many other draught horses are used only for showing and, unless exercised hard, such cases may even suffer undetected total (unilateral) RLN.

The age of affected horses at referral also reflected the type of work they performed, with many of the National Hunt racehorses and hunters not broken until they were age 4–5 years. Consequently, the clinical signs of RLN in these cases were not usually apparent until they first started fast work. This is in contrast to horses which race on the flat, where training and, consequently, the detection of clinical signs of RLN, begins at age 2 years. This difference in workload would explain the older age of RLN-affected horses in this survey (median age 6 years) compared with the findings of most other studies. For example, Cook (1970) termed RLN as 'a disease of childhood' and Marks *et al.* (1970), Goulden and Anderson (1981a) and Robertson (1991) all state that RLN is found most commonly in horses under age 3 years.

The large proportion (77%) of male horses affected with RLN in this study may simply reflect the gender ratios of a mixed-breed working population of horses in northern Britain. For example, in a study of referred pulmonary cases from this same population of horses, 71% of horses were male (Dixon *et al.* 1995). However, some authors, including Cook (1970) and Goulden and Anderson (1981a), suggest a true increased prevalence of RLN in male horses.

The presence of abnormal exercise-related 'noises' was the most prominent presenting sign in this disorder, being reported in 90% of affected cases prior to referral, and recognised in most of the remaining horses at this clinic. Although owners and trainers could recognise the presence and usually the significance of such 'noises' they were poor at describing the relationship of these 'noises' to the phases of respiration. Additionally, they often described these 'noises' as occurring at too early a stage of exercise (e.g. at the trot) when in fact they were found not to occur until horses were at the canter when examined at this clinic. In contrast to some other RLN surveys, poor exercise tolerance was recognised in only 64% of RLN cases. In most of the other 36% of cases, experienced horse-owners had recognised the significance of these 'noises' at an early stage of training and had immediately referred the horses for respiratory investigation.

Seven of the 351 RLN cases (2%) had bilateral laryngeal paralysis, which is similar to Cook's (1965) finding of 2% and Goulden and Anderson's (1981b) of 2.3%. Bilateral laryngeal paralysis is more difficult to detect endoscopically and grade than unilateral laryngeal paralysis, due to the absence of a normal side for comparison. In horses with a marked degree of unilateral laryngeal paralysis, it is possible that a lesser degree of paralysis of the contralateral side could be missed.

A high proportion (40%) of our RLN cases had intercurrent disorders, including respiratory disorders in 17%. Similarly, Goulden and Anderson (1981a) found intercurrent disorders in

46% of their RLN cases, including a 29% incidence of (clinically diagnosed) DDSP. These authors also found that 11% of 127 cases of laryngeal paralysis were non-RLN in aetiology, in contrast to the current study where just 6% (of 375 cases) were diagnosed as having non-RLN laryngeal paralysis. It is accepted, however, that without complete pathological evaluation of the laryngeal muscles, recurrent laryngeal nerves and brains of horses affected with laryngeal paralysis, the classification of such cases as being RLN or otherwise cannot be confirmed. The criteria used to differentiate RLN cases (Table 2) from non-RLN cases (Tables 3 and 4) were not always clear-cut, particularly with bilaterally-affected cases. For example, *Cases 4* and *5* (Table 3; bilateral non-RLN cases) could have been classified as bilateral RLN cases, except that they had shown sudden marked improvement in their laryngeal function, which would not be expected in RLN cases. Similarly, *Case 4* (Table 4), where left laryngeal paralysis was diagnosed following oesophageal surgery (without any evidence of cervical or cranial sympathetic nerve dysfunction), may have been due to RLN rather than to surgical trauma.

It is interesting that 11 of the 12 cases (92%) of bilateral laryngeal paralysis were ponies compared to the RLN group, where only 4 (1%) cases were ponies. It is even possible that one of the 4 ponies in the RLN group that was reported to have had stridor at rest, but showed unilateral laryngeal paralysis at this clinic, may have suffered from an intermittent bilateral laryngeal paralysis. Pearson (1991) reported 3 cases of dyspnoea associated with hepatic encephalopathy, all of which were ponies. The mechanisms by which hepatic dysfunction can cause encephalopathy have been reviewed by Maddison (1992) and Mair (1997) and, more specifically, the possible pathogenesis of bilateral laryngeal paralysis secondary to liver failure has been reviewed by McGorum *et al.* (1999). In general, it would appear that by unknown (apparently central nervous system related) mechanisms, ponies are more susceptible to bilateral paralysis, both secondary to known insults such as hepatic encephalopathy and general anaesthesia, as well as for other unknown reasons, than are larger breeds of horses. This area deserves further attention.

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