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Summary

Reasons for performing study: The effectiveness and best method to perform a partial arytenoidectomy in racehorses is unclear. This study was performed to evaluate the success of and complications that can occur after a unilateral partial arytenoidectomy with primary mucosal closure in Thoroughbred racehorses.

Hypothesis: Partial arytenoidectomy is an effective surgical procedure to return Thoroughbred racehorses, afflicted by arytenoid chondropathy or a failed laryngoplasty, to preoperative levels of performance.

Methods: Seventy-six Thoroughbred racehorses admitted to the New Bolton Centre between 1992 and 2006 were assessed. Information was obtained from the medical records about the horse, laryngeal abnormalities, surgery and other findings during hospitalisation. Racing information was evaluated relative to those independent variables by an analysis of variance with a level of significance of P<0.05.

Results: Arytenoid chondropathy was the presenting complaint in 54 horses and failed laryngoplasty in 22 horses. Thirteen horses (17%) underwent a second surgery for laser excision of intralaryngeal granulation tissue at the arytenoidectomy site. Seventy-three horses were discharged from the hospital and racing outcome was evaluated. Sixty horses (82%) raced after surgery and 46 horses (63%) raced 5 or more times after surgery. The median time from surgery to the first start was 6 months. The average earnings/start was not significantly different before and after surgery. There was no association between earnings after surgery and age, gender, location of lesion, type of lesion, duration of tracheal intubation or undergoing a second surgery.

Conclusions and potential relevance: A Thoroughbred racehorse is likely to race after a unilateral partial arytenoidectomy with primary mucosal closure and return to a preoperative level of performance.

Introduction

Arytenoidectomy is performed on horses with respiratory obstruction secondary to arytenoid chondrosis or laryngeal hemiplegia. The goal of the surgery is to provide a larger laryngeal lumen without it resulting in aspiration. Several techniques have been described and the partial arytenoidectomy results in improved respiratory mechanics compared to other techniques (Belknap et al. 1990; Williams et al. 1990; Hay et al. 1993; Lumsden et al. 1994), but does not return respiratory mechanics to normal (Radcliffe et al. 2006). Despite this, partial arytenoidectomy has traditionally been associated with a fair to guarded prognosis for return to racing and a high post operative complication rate (Speirs 1986; Tulleners et al. 1988a; Dean et al. 1990; Barnes et al. 2004). In one author’s experience (E.J.P.), the number of horses undergoing a partial arytenoidectomy with a primary mucosal closure that race is higher and the complications lower than those previously reported.

The objectives of this study were to: (1) determine the success of racehorses having a unilateral partial arytenoidectomy with a primary mucosal closure either for failed laryngoplasty or arytenoid chondritis; and (2) examine the types and rates of post operative complications following partial arytenoidectomy. Our hypotheses were that: (1) the majority of horses would return to racing and have a successful outcome following partial arytenoidectomy; and (2) there would be few post operative complications.

Materials and methods

Medical records

The medical records of racehorses that underwent a partial arytenoidectomy with a primary mucosal closure by one of the authors (E.J.P. or E.P.T.) between 1992 and 2006 for either a failed laryngoplasty or arytenoid chondrosis were reviewed. A chondritic arytenoid was defined as having an abnormally shaped corniculate cartilage, with limited motion, with or without areas of mucosal disruption (Fig 1). The presence of arytenoid granulation tissue alone did not constitute a chondropathy. Information obtained from medical records included subject details (age, breed, gender), history (a noise vs. no noise), lesion type (laryngeal hemiplegia vs. arytenoid chondritis), lesion location (left, right or bilateral arytenoid cartilage), surgical time, the post operative complication of dysphagia (presence or absence of clinical signs), post operative management (duration of tracheal intubation post operatively), days to re-evaluation, undergoing a second surgery for removal of granulation tissue.

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Surgery

All horses received perioperative i.m. penicillin (22,000 iu/kg bwt) and phenylbutazone (4.4 mg/kg bwt i.v.) and i.v. dexamethasone (0.5 mg/kg bwt) intraoperatively. All horses underwent a tracheostomy, either prior to or immediately after induction of general anaesthesia, depending on the anticipated difficulty of tracheal intubation, and unilateral partial arytenoidectomy via a standard laryngotomy as described previously (Parente 2007a). Care was taken to free a dorsally or caudally based mucosal flap from the body of the arytenoid prior to removing the arytenoid. The abaxial border of the arytenoid was freed of its muscular attachments with a combination of sharp and blunt dissection, often using a periosteal elevator. The muscular process was sharply transected to remove the arytenoid. Mucosal closure over the defect was performed with 3-0 polyglactin 910 in multiple lines of simple continuous patterns. The ventral border of the mucosal flap was left open to drain and the saccule and vocal cord were resected. Any granulating ‘kissing’ lesions on the opposing arytenoids were sharply resected. The laryngotomy incisions were not closed. The horses were recovered from anaesthesia with a tracheostomy tube in place that often was maintained until the following morning, and then removed or changed if required to ensure a patent airway.

Post operative treatments

Horses were maintained on oral phenylbutazone (0.2 mg/kg bwt q. 12 h) and oral trimethoprim sulphonamethoxazole (33 mg/kg bwt q. 12 h) for one week. The laryngotomy and tracheostomy incisions were cleaned daily and the horses maintained in a stall for one month prior to re-evaluation, and then turned out for a second month before resuming exercise. Horses which were considered to have excessive granulation tissue at the time of re-evaluation underwent transendoscopic laser excision on an outpatient basis as previously described (Parente 2007b).

Outcome measurements

Outcome was obtained from race records (Bloodstock Research Information Services, Lexington). Outcome measurements were categorical and continuous: 1) raced post operatively (raced vs. did not race); 2) 5 or more starts after surgery (<5 vs. ≥5), 3) total number of starts post operatively; 4) total earnings post operatively; 5) months to first start; and 6) average earnings/start for the 3 starts immediately preceding surgery and the first 3 starts after surgery. Horses that did not have 3 starts before and after surgery were excluded from this analysis.

Statistical analysis

A censored analysis of data was performed using a Fisher’s Exact test for categorical data and a mixed model analysis of variance (ANOVA) for continuous data. Horses subjected to euthanasia prior to discharge were excluded from outcome analysis. The level of significance was P<0.05. Specifically, the association between outcome measurements (raced post operatively, 5 or more starts) and age, gender, history, lesion type and location, post operative complications, and having a second surgery for removal of granulation tissue was determined using a Fisher’s Exact test. Continuous data were analysed using an ANOVA. The dependent

Fig 1: (a) The endoscopic appearance of a left arytenoid chondropathy with axial granulation tissue and axial kissing lesion on right arytenoid; (b) intralaryngeal granulation tissue one month after partial arytenoidectomy, the granulation tissue was subsequently removed via transendoscopic laser excision; (c) larynx 3 months after initial surgery (from Parente et al. 2003).
variables were the outcome measurements (total number of starts post operatively, total earnings post operatively, months to first start post operatively, average earning/start for the 3 starts before and after surgery). The class variables were age, gender, history, lesion type, lesion location, post operative complications and having a second surgery for removal of granulation tissue. Data are presented as mean ± s.d.

**Results**

Seventy-six horses met the selection criteria, including 30 geldings, 23 females and 23 intact males, median age 4 years (range: 2–10 years). Seventy-two horses had a history of abnormal respiratory noise during exercise and the history was unknown in 4 horses. Arytenoid chondropathy was the presenting complaint in 54 horses and failed laryngoplasty in 22 horses. Lesions were left-sided (n = 52), right-sided (n = 20) and bilateral (n = 4). Thirty horses had endoscopically apparent axial granulation tissue lesion present on the affected corniculate cartilage and 14 had an axial lesion on the nonchondritic arytenoid (5 horses had an axial lesion only on the nonchondritic arytenoid). The duration of follow-up was 8 months to 9 years.

The median anaesthesia time was 130 min (range: 90–180 min) and surgical time was 90 min (range: 60–140 min). Some horses were reported to cough while eating on the morning following surgery, yet none showed signs of more dramatic dysphagia with food or water exiting the nares, prompting long term hospitalisation or treatment. The median duration of post operative tracheal intubation was one day and 5 horses had tracheal intubation for longer (range 2–6 days). The median hospital stay was 5 days (range: 3–13 days), but none were required to stay for treatment of dysphagia. Forty-six horses (46/76; 60%) were re-evaluated by one of the authors (E.J.P. or E.P.T.) following discharge from the hospital. The median duration of time to re-evaluation was 35 days (range: 15–127 days). Thirteen horses (13/76; 17%) underwent a second surgery for laser excision of intralaryngeal granulation tissue from the arytenoidectomy site (Fig 1). Eleven of these 13 raced post operatively.

Three horses were subjected to euthanasia for colic (n = 2) or laminitis (n = 1) after surgery, and were excluded from the outcome analysis. An additional 3 horses developed signs of colic after surgery, but responded to medical management, and were included in the analysis. Therefore, 73 horses were used in the final statistical analysis.

**Outcome**

Sixty horses (82%) raced after surgery and 46 (63%) raced 5 or more times. Geldings were more likely to race post operatively and to race 5 or more races (90% and 83%, respectively) compared to females (69% and 43%, respectively) and intact males (78% and 56%, respectively). There was no association between lesion type (failed laryngoplasty vs. chondropathy) or the presence of an axial lesion and any outcome measurement. There was also no association between lesion location and other outcome measurements. Only 40% of the horses (2/5 horses), requiring tracheal intubation for longer than one day, raced post operatively while 85% of the horses (58/68) that had tracheal intubation for just one day raced post operatively (P = 0.02). There was no association between duration of tracheal intubation and other outcome measurements. There was no association between undergoing a second surgery for granulation tissue removal and any outcome measurement.

The median time from surgery to the first race was 6 months (range: 2–20 months). The median number of starts after surgery was 8 (range: 0–68). Horses that required tracheal intubation for longer than one day had a significantly longer period from surgery to the first start (P = 0.04). There was a trend for younger horses to have a longer period between surgery and first start; however, this did not reach statistical significance (P = 0.06). There was no association between the time from surgery to the first start and gender, location of lesion, type of lesion, or undergoing a second surgery. Females had significantly fewer starts after surgery compared to geldings (P = 0.04). There was no association between earnings after surgery and age, gender, location of lesion, type of lesion, duration of tracheal intubation or undergoing a second surgery. The median earnings after surgery was $10,828 (range $0–$152,660). There was no association between earnings after surgery and age, gender, location of lesion, type of lesion, duration of tracheal intubation or undergoing a second surgery. Fifty-eight horses (79%) had 3 starts after but not before surgery. Forty-eight horses raced at least 3 starts before and after surgery. The average earnings/start for 3 races before and 3 races after was not significantly different ($2366 ± 766 vs. $1865 ± 1047; P = 0.53).

**Discussion**

There is limited information about success in performance horses after arytenoidectomy. Previous studies have reported a varied success rate depending on the owner/trainer expectation and the definition of success (Speirs 1986; Tulleners et al. 1990; Barnes et al. 1994). Since the tissue that remains after arytenoidectomy in either a chondropathy or failed laryngoplasty is the same in both cases, only if the chondritis caused soft tissue damage beyond the margins of the arytenoid or created great difficulty in removing the arytenoid, should a difference in outcome be expected.

Eighty-two percent of the horses raced post operatively and 63% raced at least 5 or more times. The higher percentage of geldings vs. females or males that continued to race in this report should be expected since geldings have no breeding value if retired from racing. It is not surprising that the type of lesion (failed laryngoplasty vs. chondropathy) did not impact the outcome, and these findings are similar to previous reports (Barnes et al. 2004). Since the tissue that remains after arytenoidectomy in either a chondropathy or failed laryngoplasty is the same in both cases, only if the chondritis caused soft tissue damage beyond the margins of the arytenoid or created great difficulty in removing the arytenoid, should a difference in outcome be expected.

Several forms and methods of arytenoidectomy have been described (Belknap et al. 1990; Hay et al. 1993; Lumsden et al. 1994; Radcliffe et al. 2006). The partial arytenoidectomy was shown to be substantially better than the subtotal arytenoidectomy at providing the least resistance to air flow under exercising conditions and is now the most commonly used arytenoidectomy procedure (Belknap et al. 1990; Williams et al. 1990; Lumsden et al. 1994). The value of maintaining a mucosal flap to obtain a partial primary closure is arguable. When comparing partial arytenoidectomy with and without primary mucosal closure in an experimental study, the final glottic size was thought to be similar, despite histological evidence of minor suture dehiscence in 3 of 4 horses with primary closure (Tulleners et al. 1988b). Horses undergoing primary closure resulted in a quicker extubation
(mean 2 vs. 4 days) and faster healing at 8 weeks vs. 16 weeks relative to those not having a primary closure (Tulleners et al. 1988b). An earlier extubation clearly indicates that a larger laryngeal lumen was present following a primary closure, at least in the early post operative period.

Primary mucosal closure after partial arytenoidectomy is not always possible in the clinical situation. Infrequently the granulation tissue overlying the affected arytenoid is so widespread that there is not enough normal mucosa remaining to attempt closure. The authors always attempted a primary mucosal closure and the few cases in which it was not feasible, were not included in the 76 horses evaluated. The number of primary closures that had some partial dehiscence in this report is unknown since this would have occurred probably between the time of discharge and re-evaluation. It is suspected that it occurred to some extent in at least 17% of the horses, since 17% had intralaryngeal granulation tissue at the time of re-evaluation.

The most recent retrospective evaluation of horses undergoing partial arytenoidectomy without a primary mucosal closure (Barnes et al. 2004) reported that 78% of the previously raced horses performed at least twice after surgery. Those authors contend that performing the arytenoidectomy without primary mucosal closure minimises surgical time and post operative complications while yielding similar results to other reports. However, the percentage of horses continuing to race 3 or more times was only 55% (Barnes et al. 2004). While it is not detailed in their report, it is implied that the attrition is probably secondary to exercise intolerance and coughing. The mean ± s.d. earnings/start was not significantly different before ($2157 ± 2117) and after surgery ($731 ± 832) despite a 3-fold decrease in the average earnings/start. The lack of statistical significance is likely because of the wide variability and small number of horses (n = 7) and there was probably inadequate statistical power to conclude there was no significant difference.

It is impossible to compare results directly between retrospective studies for many reasons, especially because of the different methods of measuring a successful outcome. Despite this, several comparisons can still be made between this study and the recent study of Barnes et al. (2004). In the present study, there was a larger number of horses, the tracheostomy tube was removed sooner and a higher percentage of horses raced more than twice. This would infer that there was some degree of success that warranted the horses continuing to race. The surgery period was not reported by Barnes et al. (2004) and, while it should be presumed that time required to obtain a primary mucosal closure is longer, the times reported here (mean 90 min) should not be a major deterrent.

Similar to the previous report (Barnes et al. 2004), the average earnings/start was not significantly different before or after surgery in this report. This could be interpreted negatively, i.e. that an improved performance should be expected after surgery. However, most horses are unable to race with a significant arytenoid chondropathy or failed laryngoplasty. Therefore, the results of 1 or 2 of the 3 races before surgery should reflect those of a horse unaffected by disease. An insignificant difference between post operative earnings/start and the preoperative earnings/start should be interpreted as returning to a similar level of performance prior to being affected by laryngeal disease.

Post operative laryngeal lumen size is likely to be a major limiting factor to a successful return to performance. Post operative granulation tissue can significantly reduce lumen size, cause substantial compromise of the laryngeal lumen, an increased respiratory obstruction, and necessitate a second surgery (Dean et al. 1990). Many horses in the present study were re-evaluated a month post operatively and 17% had a second surgery to remove granulation tissue at the arytenoidectomy site. While it is beyond the scope of this study to assess accurately, this procedure may have improved the ability of this group of horses to race post operatively. This has not been addressed in earlier studies.

Post operative aspiration is probably the next limiting factor to a successful outcome. Speirs et al. (1986) reported that 36% of the horses demonstrated dysphagia with food or water from the nares after arytenoidectomy. A rongeurs was used to extract the arytenoid from the larynx by Speirs et al. (1986). In the present report, greater care was taken to extract the arytenoid en bloc and minimise adjacent soft tissue damage. Theoretically, this would minimise the impact on deglutition and there were no accounts of dysphagia in the medical records of the horses. While there were no signs of gross dysphagia, experimental studies have shown significant cytological abnormalities in tracheobronchial aspirates after a partial arytenoidectomy (Radcliffe et al. 2006). The potential impact of these abnormalities on racing performance is unknown. There was no assessment in this retrospective study of the degree of tracheal contamination and consequently no evidence to determine its possible effect on performance.

The clinical relevance of an abnormal post operative noise after surgery on performance of a racehorse is unclear. While Tulleners et al. (1988a) reported that many of the horses in their retrospective study made some abnormal noise, other reports could not positively correlate an increased luminal size with less noise, as might be anticipated (Brown et al. 2004). The presence of an abnormal respiratory noise post operatively was not recorded in this study, but it is anticipated that many horses made some abnormal noise and it may have had little relevance to performance.

Several factors may have contributed to an apparently higher success rate in this report compared to previous reports. Many of these horses had unilateral disease with only granulating ‘kissing’ lesions on the contralateral arytenoid. Bilateral arytenoidectomy was not considered as a surgical option, even when both arytenoids were affected because of significant adverse sequelae (Harrison et al. 1988). Careful dissection to remove the entire cartilage and minimise trauma to adjacent muscle may have reduced the risk of post operative aspiration and a primary mucosal closure was performed in all cases. Also, endoscopic laser resection of the 13 horses with post operative intralaryngeal granulation tissue may have allowed some of these horses to race, when previous studies may not have addressed this complication.

This report demonstrates that partial arytenoidectomy can result in a successful outcome. While technically more demanding and time consuming, a primary mucosal closure with a partial arytenoidectomy appears to have advantages over leaving the defect to heal in entirely by second intention.

Manufacturer’s address


References


**Author contributions** All aspects of this study were by E.J.P. and L.L.S. E.P.T. is also included as an author as he contributed a significant number of cases to the retrospective.