56 Cases of Rib Fractures in Neonatal Foals Hospitalized in a Referral Center Intensive Care Unit from 1997–2001

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Early recognition of life-threatening or serious injury is the necessary precedent for the implementation of appropriate therapeutic intervention. In the population of foals beginning life in a pediatric intensive care setting, rib fractures can be a significant cause of morbidity and mortality. This retrospective study describes the presentation, assessment, and care of foals with rib fractures, and documents the short-term outcome of hospitalized foals with this injury at the neonatal intensive care unit at Hagyard Davidson McGee, division of Internal Medicine, in the period 1997–2001. Authors' address: Hagyard Davidson McGee Assoc., PSC, Internal Medicine, 4250 Ironworks Pike, Lexington, KY 40511. © 2001 AAEP.

1. Introduction

Past studies which profiled rib fractures and associated sequelae in foals have examined the prevalence and clinical features of this injury in foals residing on stud farms, and documented a favorable outcome in these foals.1 Earlier reports demonstrated the potential for rib fractures to represent a mortal injury in the neonate.2 Broken ribs are a common complicating clinical presence in neonatal foals admitted to the neonatal intensive care unit (NICU) at this practice, and the care of such foals is often influenced by or extended due to complications arising from damage to nearby structures, including the heart and lungs (Figs. 1–5). The gravity of such injuries is reflected in statistics from a 1995 report from the Livestock Disease Diagnostic Center in Kentucky,3 which documented that rib fractures were the most common fractures in foals necropsied at 1 day of age and younger, and were the second most common type of fracture in foals necropsied from 2 days to 6 months of age. Birth trauma is assumed to be the source of neonatal rib fractures. Currently, it remains undetermined whether there is a breed disposition to the problem, but in the Jean study, neither fetal thoracic diameter nor weight played a role in the occurrence of birth trauma, although dam parity and a history of dystocia were statistically significant as risk factors. Though most cases of rib fractures in human pediatric patients are documented to be secondary to trauma from physical abuse, those cases which are ascribed
to birth trauma are linked to dystocia and heavy birth weight.\textsuperscript{4}

The population of foals in this study was a hospital population, and thus was comprised of foals which were, by definition, abnormal in some aspect of neonatal clinical status. Of a total of 56 foals, 49 were Thoroughbred, 4 were Standardbreds, and the remaining 3 foals were other breeds. This distribution closely reflects the admission logistics for breed distribution at this NICU. Many of the foals admitted to the Hagyard Davidson McGee (HDM) NICU were presented for signs relating to sepsis or birth asphyxia (HIE), and the rib fractures were an additional, ancillary finding. Farm foaling personnel in this region are often trained to monitor newborn foals for broken ribs, and equine veterinarians servicing the farms often include an assessment of the thoracic cage in the course of performing routine postpartum well-foal checks. Numerous cases of fractured ribs in foals likely occur but are uncomplicated and remain unnoticed and unreported in foals which do not become ill or present to referral centers. The 1999 study by Jean et al detailed the prevalence of rib fractures occurring in foals born on a Thoroughbred stud farm. In that report, fractures or thoracic injury were present in 55 out of 263 foals, and clinically apparent consequences were not documented in any of these foals. However, in foals presenting to the intensive care unit at this referral practice, rib fractures are a significant contributor to aggravated morbidity and mortality in affected neonates. The clinically significant consequences of rib fractures include pulmonary contusion, hemothorax, pneumothorax, diaphragmatic hernia, hemopericardium, and death from myocardial laceration. Multiple cases of newborn foals managed each season at our hospital have unfavorable outcomes as a result of this injury, and the aim of this

Fig. 1. Displaced rib fracture fragments showing distal fragment piercing lung with resulting pulmonary contusion.

Fig. 2. Minimally displaced rib fracture fragments with no underlying pulmonary contusion.

Fig. 3. Pulmonary contusion, thickened pleura, and hemothorax secondary to rib fracture.

Fig. 4. Thrombus overlying site of separated rib fragments, with distal fragment shown piercing lung and causing contusion of parenchyma.
article is to describe the assessment, treatment, and short-term outcome of the injury in the population of foals presenting to the HDM NICU.

2. Materials and Methods
A retrospective review was undertaken of the records from 1997 to 2001 of all foals aged 3 days and younger hospitalized at the neonatal intensive care unit and diagnosed with fractured ribs. Clinical and necropsy records were reviewed for signalment at admission, parturition history, chief complaint, concurrent diagnoses, number and location of rib fractures, associated injuries, parity of the dam, and whether the foal survived to discharge.

3. Results
We identified 56 case records which included a diagnosis of fractured ribs which met the criteria for inclusion in the study. Of these foals, fractured ribs was the sole diagnosis in 18 cases, while they occurred with sepsis or maladjustment (birth asphyxia) in 28 cases. Male foals were affected three times as often as fillies, with 42 colts and 14 fillies. Of the 56 study cases, only 5 births had been recorded as “normal” or “uncomplicated,” while 35 of the cases were dystocias. A birth history was not available in 16 of the cases. Information regarding the parity of the dam was not available in 32 cases, and maiden mares and multiparous mares were equally affected in the remaining cases. In this study population, 27 foals died and 29 survived to discharge. Of the foals which did not survive, 14 died directly as a result of complications attributable to rib fractures. The remaining foals died or were euthanized due to complications of sepsis or HIE. Eleven of the 14 foals dying from direct complications of the fractures suffered cardiac laceration or contusion; of these cases, 6 had fractures involving the left rib arcade and 5 had fractures on the right side. Two foals suffered diaphragmatic tearing and subsequent hemoabdomen in addition to hemothorax; both these foals died, with the affected ribs being on the right side in one case and on the left side in the other. Three foals presented in hemorrhagic shock from intracavitary blood loss and were treated with thoracentesis and removal of some of the pleural blood, plus whole blood transfusion and supportive intravenous fluids. Two of these three foals survived to discharge. Pulmonary contusion was the single most frequent condition presenting as a complication to rib fractures, with 27 cases recorded. Foals that had pulmonary contusion, even when recorded as “severe,” survived to discharge if myocardial damage was not also present. Foals with 5 or more fractured ribs usually died; of 13 such foals, 3 survived to discharge. Two of these 3 surviving foals underwent surgery to stabilize the affected rib arcade. In 19 cases, the exact number of involved ribs was not specified, but instead was given as “multiple.” The highest number of broken ribs occurred in the one foal in the study which suffered fractures on both sides (9); this foal did not survive.

4. Discussion
Physical examinations performed on foals admitted to the HDM NICU typically include sonographic evaluation of the thorax and abdomen in the course of obtaining a baseline and comprehensive body of information regarding the patient. Ultrasound was used in the assessment of all foals in the study versus radiography because of the modality's superior sensitivity in the detection and characterization of thoracic abnormalities. In our hands ultrasound effectively identifies non-displaced or “greenstick” fractures, and is superior to radiography at detecting and characterizing associated soft tissue damage. Radiography of human chest trauma patients is known to underestimate the presence and extent of rib fractures, pneumothorax, and pulmonary contusion. The use of ultrasound permits the examiner to identify even small volumes of pleural fluid, to immediately ascertain whether fluid in the chest is unilateral or bilateral, to characterize it as cellular and therefore likely to be blood in neonatal foals, and to observe changes associated with contusion or pneumonia in the underlying lung. The degree of fracture segment displacement and the proximity of bone ends to the heart can be immediately visualized, and the presence of pericardial effusion and peritoneal fluid are also more easily and sensitively evaluated with ultrasound than with radiography. The fractured ribs themselves can be well-visualized with ultrasound, even when non-displaced, and the technique requires less positioning and manipulation of the injured patient than does radiography. Since associated damage to adjacent soft tissues is the source of problems in foals with this injury, ultrasound is the diagnostic modality of choice at our clinic, and abdominal and thoracic
imaging constitutes part of the admission physical exam for most foals. 

Signs that should direct an examiner’s attention to the possibility of costal fractures include groaning or grunting in the foal, plaques of subcutaneous edema overlying the ribs or along the ventrum of the thorax, especially behind the elbows, and flinching when the rib area is palpated. Audible or palpable crepitation or a clicking sensation when the hand is gently pressed over an affected area is common. Nearly all the fractured ribs in the foals studied were broken at or within several centimeters of the costochondral junction. The distal rib fragment tends to displace axially and is usually the instrument of myocardial injury when it occurs. Subcutaneous emphysema is occasionally present, and though not recorded frequently in association with rib fractures in the records examined in this study, the distinctive presence of subcutaneous emphysema, particularly over the sides of the thorax or in the axillary area, should alert the examiner to the possibility of a broken rib. Wetting of the hair with alcohol or water significantly increases the visibility of chest wall indentation and plaques of edema overlying injured ribs. In some cases, it is necessary to clip the hair in order to obtain the best images, but in our hands, alcohol alone as a wetting agent is often sufficient. Although fractured ribs are attended by significant pain in humans, after several days of hospitalization many foals will demonstrate normal vigor and play activity in the stall, even when multiple broken ribs are present. For this reason, analgesic administration should be judicious in affected foals, as any movement or jostling of the thorax can cause rib fragments to lacerate internal vascular structures or the heart, resulting in sudden death. Not surprisingly, myocardial laceration or puncture were unequivocally fatal events in this study. This complication occurred equally among fractures involving both the left and right rib arcades. Sudden death is not an uncommon feature of broken ribs in foals, and clients are warned frankly of this unfortunate possibility when foals are discharged from the hospital. Recommendations for 2–3 weeks of confinement to a small space, with sedation if necessary, are typically included in the treatment orders for discharged foals.

Flail chest occurs when several consecutive ribs are fractured, leading to an incompetent segment of chest wall. The foal’s respiratory efforts are hampered by the failure of the affected rib arcade to lift and participate in the process of creating negative pleural pressure for inspiration. During expiration, the failure of the affected chest segment to collapse as a unit likewise impedes the normal development of positive airway pressure and timely exhalation. When a flail chest is present, the involved segment of chest wall will sink inwards during the inspiratory excursions of the abdomen and diaphragm.

Foals presenting to the HDM NICU with rib fractures and concomitant pulmonary injury are generally managed by encouraging lateral recumbency with the affected side down. When pulmonary contusion is significant, positioning the foal with the undamaged lung on top minimizes ventilatory embarrassment. Foals which struggle excessively or are active enough when ambulatory to warrant fear of displacement of a fracture fragment may be sedated to encourage immobility and rest. These generalizations are subject to modification in foals with pneumonia associated with sepsis, in which sternal positioning is required for optimal gas exchange and overall well being. Rib fractures can lacerate intercostal blood vessels, the internal thoracic artery, may bleed from the fractured bone ends, or tear intercostal muscles. Contusion and extravasation of blood in the thoracic wall was a finding in several foals in this study, and the pulmonary artery was lacerated in one case. The resultant hemothorax may compromise the foal by leading to cardiovascular collapse from intracavitary volume loss and shock, and by the tamponade effect on the lungs of fluid and positive pressure in the pleural space. When thoracic auscultation or ultrasound demonstrated the presence of hemothorax, the pleural blood was not removed if the foal did not experience significant dyspnea, to allow for autotransfusion and the ameliorating effect of positive pleural pressure on continued bleeding. When respiratory compromise was judged to be present as a result of hemothorax, thoracentesis was performed to remove some or all of the blood in the pleural space. In the three cases in this survey when the foals presented with hemorrhagic shock secondary to blood loss into the pleural space, blood transfusion along with the judicious removal of free blood successfully stabilized these foals. Two of the three foals treated with blood transfusions and thoracentesis survived to discharge. Foals were also treated with broad-spectrum antibiotics, intravenous fluid support, and the attendant treatments and instrumentation typical in foals suffering the effects of birth asphyxia or sepsis, since most of the affected foals had these conditions as the primary presenting complaint. The feasibility of surgical treatment of fractured ribs has been pursued in a number of foals at this practice since 1999, when the injuries involve ribs which are in proximity to the heart and when the foal’s value dictates the procedure to be feasible. The results of a survey of foals managed by the application of dynamic compression plates to fractured ribs are currently being assembled for profiling in a future presentation. The long-term monitoring of foals successfully discharged from the hospital and returned to farm care is done with serial ultrasound imaging. The formation of a hematoma or thrombus at the broken bone ends is typical of a rib fracture injury in the acute...
stages. Serial visits to image the site at the farm document the evolution of this finding to bony callus formation, and eventual smoothing and remodeling of the callus with time. Four to six weeks are considered to be necessary for stabilization of the thoracic wall following rib fractures. Deformation of the lung surface and thickening of the visceral pleura may be semi-permanent to permanent findings in the long-term assessment of these foals. Some chronic fractures may be incidental findings when the foal is being examined at an older age. For example, previous fracture sites and deformation of the visceral pleura by the bony callus are an occasional finding in older foals being imaged for rhodococcal pneumonia or other thoracic disease.

Though previous studies have documented fractured ribs in foals to be benign and unassociated with significant complications, in the population of neonatal foals hospitalized at this referral center, the injury is a significant cause of morbidity and mortality. Foals should be examined for this injury in postpartum assessments, and foals born in complicated or difficult deliveries should be especially scrutinized. In this study colts were more commonly affected than fillies, a finding which may be related to size and resultant birth trauma. A higher number of involved ribs was associated with increased risk of death in our foals, a finding which corroborates findings in similar studies of this injury in children. Though not documented by this study, the human propensity to assist in the birth of foals by applying traction to the forelegs during the delivery process may also play a role.

References and Footnote


*Robert Hunt and F.T. Bain, personal communication.*