Reports of Retrospective Studies

Elective cesarean section in mares:
Eight cases (1980-1989)

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Summary: From 1980 to 1989, 8 cesarean sections were performed on an elective basis in 5 mares. Four mares had partially obstructed pelvic canals; 2 of these mares had previously lost foals because of dystocia. Cervical adhesions that might obstruct passage of the fetus through the pelvic canal was suspected in the fifth mare. Cesarean section was performed prior to mares entering the first stage of labor. Readiness for birth was estimated by development of the mare's mammary gland and the presence of colostrum in the udder. A ventral midline celiotomy provided excellent exposure and healed without complications in all instances. Eight viable foals were produced. One foal developed bacterial pneumonia and septicemia after surgery and died. Follow-up evaluation of the 7 foals discharged from the hospital failed to reveal complications associated with elective cesarean section.

All mares survived the procedure. Fetal membranes were retained for up to 72 hours following surgery; however, systemic complications secondary to retained placenta did not develop. Three mares were bred subsequent to elective cesarean sections, with each mare conceiving the year following surgery. Three foals were produced by 1 mare and 2 foals have been produced by another mare by elective cesarean section.

Cesarean section is seldom necessary to resolve equine dystocia because most problems encountered with foal delivery can be corrected by fetal manipulation. In uncomplicated cases in which malpresentation or abnormal fetal posture is promptly identified and rapidly corrected, a live foal can be delivered. However, when dystocia is protracted and lengthy obstetric manipulations are attempted, the usual result is delivery of a dead foal.

With experience, up to 90% of mare dystocias can be managed by mutation, forced extraction, and partial fetotomy. Cesarean section is indiacted whenever assisted delivery cannot rapidly andatraumatically produce a live foal, and in dead foals, when delivery unduly risks the life or future reproductive capability of the mare. In a group of over 600 mares with severe dystocia, approximately 60 required cesarean section. The most common indication for cesarean section was transverse presentation (36), followed by uterine torsion (10), malposture accompanied by uterine involution and fetal emphysema (5), malposture and injury (4), oversized fetus (4), and deformed or narrow pelvis (2).

Mare survival rates should approach 90% when cesarean section is performed on healthy, uninjured mares. However, because of complicating factors, only 80% of mares treated by cesarean sections survived as reported by Vandeplassche. Of the aforementioned indications for surgical intervention, highest mare mortality was associated with uterine torsion (39%), transverse presentation (20%), and malposture and injury (14%). The most frequent cause of death in these mares was uterine hemorrhage. However, with the advent of a hemostatic stitch along the edges of the incised uterus prior to closure of the uterotomy, the risk of fatal uterine hemorrhage was markedly reduced. Other conditions that contributed to mortality were peritonitis, vaginal hematoma, surgical shock, and incisional herniation.

Retained placenta, decreased fertility, and a predisposition to abortion are also reported as complications subsequent to cesarean section in mares. Retained placenta is reported in approximately 50% of the cases, causing endometritis and potentially predisposing the mares to toxic metritis-laminitis syndrome. Decreased fertility, with conception rates of 50% reported, is considered a sequela to the retention of fetal membranes, delayed uterine involution, and endometritis. Furthermore, perimetrial adhesions and sclerotic alteration of the uterine wall are responsible for an increased risk of abortion. Consequently, only 35 to 40% of the mares are expected to produce live foals following cesarean section.

Cesarean section in mares has been associated with foal survival rates of <30%, a disappointing...
number when compared with the expected survival rate for calves delivered by cesarean section (85%).

Low foal survival rates are attributed primarily to the severity and duration of the dystocia. Prolonged stage labor (>30 to 40 min) predisposes the mares to premature placental separation resulting in fetal asphyxia and death. Therefore, expedient correction of the dystocia and rapid delivery are required to salvage the foal. Even when dystocia is anticipated and foaling occurs in the hospital environment, it may be difficult to determine the need for cesarean section and to perform the surgery in time to save the foal.

Elective cesarean section in mares has been described for the production of gnotobiotic foals used for viral research; 14 elective cesarean sections were performed on 12 mares, producing 12 viable foals. Recovery from surgery was uncomplicated in 12 instances. One mare died because of incisional evagination precipitated by violent straining secondary to uterine prolapse. Expulsion of the fetal membranes was delayed 10 to 72 hours following delivery in all instances; however, only 1 mare developed systemic disturbance. Inadvertent inclusion of the atlantochorion in the uterine closure contributed to retention in 3 mares. Conception rates following elective cesarean section were 80%. In 2 mares, cesarean section was performed twice, and in 1 mare, 3 times.

The purpose of the retrospective study reported here was to evaluate the treatment protocols and report the long-term results of 8 elective cesarean sections performed for management of mares with a history of, or a high index of suspicion for, severe dystocia.

Criteria for Selection of Cases

Medical records detailing elective cesarean sections performed at the Texas Veterinary Medical Center between 1980 and 1989 were reviewed. Five mares were identified; 3 cesarean sections were performed on 1 mare and 2 on another mare, with the remaining 3 mares undergoing 1 cesarean section each. Signalment, history, results of physical examination, treatment protocols, complications, and survival rates of mares and foals were assessed. Subsequent breeding histories of mares and long-term follow-up evaluation of foals were obtained by conversation with owners or referring veterinarians from 6 months to 9 years after cesarean section was performed.

Materials and Methods

Timing of surgery—The proper time for surgical intervention was determined by use of criteria established for induction of parturition in mares. When available, previous gestation lengths and foaling histories were used as guidelines to determine approximate foaling dates. Specific indication for cesarean section was the presence of colostrum in a well-developed udder. A rapid strip method of assaying changes in mammary secretion electrolyte concentration was used to aid in determining readiness for birth in the most recent cesarean section.

Surgical technique—Ampicillin sodium (22 mg/kg of body weight, iv, q 6 h) or penicillin G procaine (22,000 IU/kg, im, q 12 h) in combination with gentamicin sulfate (2.2 mg/kg, im, q 12 h) were administered during surgery. The ventral portion of the abdomen extending from the udder to the xiphoid process was clipped and scrubbed in preparation for aseptic surgery and oxygen was insufflated (15 L/min) via nasotracheal tube for 5 to 10 minutes prior to induction of anesthesia. In cesarean sections 1 through 4, positioning in dorsolateral (approximately 25 to 30° lateral to dorsal recumbency) recumbency was induced and maintained with guaifenesin (220 to 330 mg/kg, iv) until the foal was delivered. Once delivery was accomplished, halothane in oxygen was administered to maintain anesthesia in the mares. Low doses of xylazine (0.22 mg/kg, iv) were administered to sedate the mares in cesarean sections 5 through 8. Positioning in dorsolateral recumbency was induced with guaifenesin (55 to 187 mg/kg, iv) combined with ketamine hydrochloride (1.1 to 2.2 mg/kg, iv) followed by the immediate administration of halothane in oxygen for anesthetic maintenance. The ventral portion of the abdomen was prepared and draped for aseptic surgery. A midventral incision beginning at a point 10 cm cranial to the udder and extending cranially for 45 to 60 cm was used to gain entry to the abdominal cavity. The gravid uterine horn containing the foal's hind limbs was identified and brought into the abdominal incision. Exteriorization of the gravid horn was aided by tilting the mare further laterally to approximately 45 to 60° dorsolateral recumbency. The abdominal cavity was packed-off with impermeable drapes to prevent fetal fluids from entering the abdomen and the exposed uterine horn was stabilized. An incision was made in the greater curvature of the gravid horn, equal in length to the distance from the foal's tuber calcis to the fetlock, and the foal's hindlimbs were exteriorized. Care was taken to avoid incising large uterine vessels. The foal was delivered being careful to avoid separating the umbilical cord until it was clamped approximately 4 cm from the foal's body wall. The foal was transferred to an adjacent area where supportive treatment was administered as necessary. If substantial hemorrhage occurred from the umbilical vessels remaining with the placenta, they were transfixed and ligated. The placenta was left in situ except at the edges of the incision where the atlantochorion was carefully separated from the endometrium for a distance of 3 cm. Hemorrhage from the incised edges of the uterine horn was controlled.

by placing a continuous interlocking stitch of 0-polyglycolic acid\(^6\) through all layers of the uterine wall around the circumference of the wound. Care was taken to avoid including the placenta in the suture line. Using the same material, the uterotomy was closed with a continuous Cushing pattern oversewn with a continuous Lembert pattern. Warm physiologic saline solution was used to remove fetal fluids and blood clots from the uterine serosa. Following uterine closure, the mare was repositioned in dorsal recumbency and the uterus was replaced in its anatomic location. Following a brief abdominal exploratory, the linea alba was closed with near-far-far-near stitches of 24 gauge stainless steel suture interspersed with simple interrupted sutures of No. 2 polyglycolic acid\(^6\) in 4 cases, near-far-near and simple interrupted stitches with No. 2 polygalactin 910\(^6\) in 1 case, and with the same pattern with No. 2 polydioxinone sulfate\(^6\) in 3 cases. Subcutaneous tissues and skin were closed in routine fashion.

**Results**

Cesarean section was performed on 1 Thoroughbred, 2 Quarter Horse, and 2 Arabian mares varying in age from 4 to 17 years. Four of the 5 mares were admitted for abnormalities of the pelvic canal. Mare 1 had fractured her pelvis approximately 2 months prior to her expected foaling date and mare 3 had fractured her pelvis as a 2 year old in race training. In mares 2 and 4, the cause of the pelvic problem was unknown. In these 4 mares, vaginal examination revealed bony encroachment and marked narrowing of the pelvic canal.

Mare 5 was referred for elective cesarean section because of a previous diagnosis of cervical adhesions. However, vaginoscopic and digital examination of the cranial vagina and external os of the cervix failed to reveal any adhesions. Nevertheless, the owner was concerned that cervical dilation might be incomplete or adhesions at the internal cervical os might result in dystocia and therefore requested an elective cesarean section.

Detailed foaling histories were available on mares 1, 2, and 3. Mare 1 had delivered a normal foal without complications in the previous year but had recently fractured her pelvis. Dystocia caused by pelvic encroachment had previously occurred in mares 2 and 3. Mare 2 had had severe dystocia with fetal death the year prior to admission. Mare 3 had lost 3 foals in the preceding 3 years because of severe dystocia. In each instance, foaling was attended, but dystocia and fetal death occurred in spite of obstetrical assistance. Mare 4 was admitted during her first pregnancy and mare 5 was known to have foaled without incident approximately 10 years prior to admission, but further details were unavailable.

Elapsed time from last breeding date to cesarean section ranged from 320 to 357 days. Foaling histories indicated that surgery was performed within 5 days of the expected due date in cesarean sections 1 through 5 and 7. Foaling history was unavailable prior to cesarean sections 6 and 8.

Mammary development was judged as minimal prior to cesarean sections 2 and 4, with only a serious secretion at the time of surgery. Moderate mammary development with a limited amount of milky secretion was found prior to cesarean section 7. Considerable mammary development with a milky secretion that was easily expressed was found prior to cesarean sections 1, 3, 5, 6, and 8. Preceding cesarean section 8, calcium and magnesium concentrations in the mammary secretions substantially increased as determined by rapid strip method.\(^4\) 

Differences were not noticed when comparing anesthetic protocols. Guaifenesin alone or in combination with ketamine hydrochloride was equally effective in inducing recumbency, allowing positioning and delivery of the foal as well as the initiation of inhalation anesthesia. In cesarean section 8, the mare was hyperexcitable and struggled excessively. Anesthetic induction was prolonged, which ultimately delayed delivery of the foal.

Midventral celiotomy provided excellent exposure for cesarean section. Exteriorization of the gravid horn containing the foal’s hind limbs was facilitated by tilting the mare to approximately 45 to 60° dorsolateral recumbency. In addition, this positioning, in combination with packing-off the uterus from the abdominal incision, aided in preventing fetal fluids from gaining access to the peritoneal cavity when the uterus was incised. A uterine incision extending from the foal’s tuber calcis to the fetlock allowed extraction of the foal without tearing the uterine horn. The only problem encountered during delivery was in foal 4 in which the umbilical cord was entangled in the foal’s hind limbs and premature umbilical separation occurred when the foal was removed from the uterus.

Foals 1 through 7 were delivered within 20 minutes of inducing positioning in recumbency. Delivery of foal 8 required 30 minutes because of difficulty in inducing anesthesia in the mare. Total surgery time ranged from 60 to 110 minutes (mean, 86 minutes). Examination of the peritoneal surfaces during repeat cesarean sections in mares 3 and 4 failed to reveal any adhesions resulting from previous surgeries. In addition, abnormalities of the uterine wall associated with previous incision sites were not identified. The only abnormality found in these mares was slight thickening and obliteration of normal tissue planes at the site of previous abdominal wall incision. However, there were no differences in the postoperative healing of the abdominal incisions with primary intention healing in all cases.

Fetal membranes were passed from 4.5 to 72...
hours (mean, 28.7 hours) following surgery. Oxytocin was administered during surgery following uterine closure and repeated intermittently (20 IU, q 0.5 to 4 h) during the postoperative period until the placenta was passed. Phenylbutazone (2.2 mg/kg, PO, q 12 h), as well as intrauterine and systemic antimicrobials, were administered throughout the period of placental retention. Mares did not develop signs of laminitis or toxemia. Examination per rectum to identify and separate perimetrial adhesions that were forming was performed after cesarean sections 1, 2, and 3.

The period of hospitalization varied from 2 to 48 days. Surgery was performed on the day of admission in 4 cases and days 2, 4, 8, and 43 after admission in the remaining cases. Prolonged gestation extended the time from admission to surgery in cesarean section 8. After surgery, mares remained hospitalized until the placenta had passed and the mare and foal were considered in stable condition. Mares and foals were discharged from 1 to 11 days after surgery, with an average postoperative hospital stay of 3.9 days.

Postoperative follow-up indicated no long-term complications to develop subsequent to cesarean section. Mares 2 and 5 were not rebred. Mares 1, 3, and 4 were bred and determined pregnant the year following surgery. Mare 1 developed severe laminitis of undetermined origin and was euthanatized during gestation. A total of 3 foals were delivered by cesarean section in mare 3. Although attempts were made to impregnate her during the same breeding seasons during which her second and third cesarean sections were performed, she did not become pregnant until the following breeding season in either instance. Consequently, she produced a foal every 2 years as opposed to yearly. Mare 3 was scheduled for her fourth elective cesarean section at approximately 340 days of gestation. Unfortunately at 335 days of gestation, she was found at pasture in severe dystocia and was euthanatized. Mammary development or other premonitory signs of foaling were not apparent prior to this occurrence. At the time of this writing, mare 4 has had 2 foals delivered by cesarean section and is currently in foal. As in mare 3, this mare has not conceived in the breeding season the cesarean sections have been performed, but has become pregnant in the following seasons.

Live foals were delivered in all 8 cesarean sections. Minimal supportive care was required in foals 1 through 7 immediately following delivery and included facilitating dependent drainage of mucus from the respiratory tract followed by intubation and oxygen insufflation for approximately 5 minutes following delivery. Normal respiration was established shortly after delivery in these foals. However, foal 8 had severe anesthetic depression at the time of delivery and required ventilatory assistance for approximately 5 minutes after delivery, followed by oxygen insufflation for an additional 20 minutes. In addition, 4.4 mEq of bicarbonate sodium/kg diluted in 5% dextrose solution was administered iv.

At the time of delivery, foals 1 through 7 appeared to be of normal size and without evidence of prematurity. In spite of 357 days of gestation, foal 8 appeared dysmature (small for gestational age [15 kg] and weak, with hyperextensible joints). Time required until the foals were able to stand unassisted following delivery varied from 0.5 to 11 hours. Foal 8 was able to stand with assistance by 3 hours after delivery but required 11 hours before it could stand unassisted. The mean time to standing unassisted in foals 1 through 7 was 2.1 hours, with 4 foals (4 through 7) able to stand unassisted less than 1 hour after delivery. Colostrum obtained from the mare, or donor colostrum, was administered via nasogastric tube to all foals within an hour of delivery. Foals were placed with the mare once she had recovered from anesthesia. All mares accepted their foals without incident and allowed nursing.

Minimal development of the mare's mammary gland was noticed prior to cesarean section 2 and 4. However, milk was produced immediately following cesarean section 2. Following cesarean section 4, the mare did not produce adequate milk until approximately 72 hours after surgery. Consequently, on the day following delivery, foal 4 weakened, became recumbent, and lost its suck-reflex. Aggressive nutritional support resolved the problem and the foal progressed without complications. The mare's mammary gland failed to noticeably develop following cesarean section 7 and the foal required supplementation with milk replacer. Unfortunately, within 18 hours of delivery, neonatal septicemia and bacterial pneumonia developed. Partial failure of passive transfer was identified as a predisposing factor. Plasma transfusion, treatment with broad-spectrum, bactericidal antimicrobial agents, and supportive care were ineffective and the foal died 24 hours after delivery. Klebsiella sp, Escherichia coli, and Enterobacter sp were cultured from multiple organs on postmortem examination.

Long-term follow-up revealed no complications in the cesarean section-derived foals once discharged from the hospital. Owners reported normal growth and development of the foals and were pleased with the results.

Discussion

Previous reports detailing equine cesarean section in clinical cases have emphasized resorting to surgery when dystocia involving a live foal could not be resolved by fetal manipulation. To our knowledge, cesarean section performed on an elective basis, prior to the onset of labor, for managing mares with a history of, or a high index of suspicion for, severe dystocia has not been reported. In such cases, clinicians often adopt the
philosophy of attending the foaling and delaying surgical intervention until they are convinced that dystocia cannot be resolved by fetal manipulation. In many instances, this is an effective way to manage mares with potential foaling problems. Unfortunately, once severe dystocia necessitates cesarean section, the prognosis for fetal viability is poor because of the rapidity of placental separation and onset of fetal hypoxia. This is well illustrated in the case of mare 3 of this study. Dystocia had resulted in stillborn foals on 3 consecutive occasions, even when foaling was attended by individuals skilled at managing equine dystocia. Three live foals were subsequently delivered by performing cesarean sections on an elective basis.

The most common indication for cesarean section reported by Vandeplassche et al is delivery of a live foal in cases of bicornual pregnancy and transverse presentation. In these instances, fetal manipulation is difficult because of the bicornual location and accompanying underdevelopment of the uterine body and elongation of the vagina and cervix. In addition, postural abnormalities of the fetus, which frequently accompany bicornual pregnancy, may further complicate vaginal delivery. In that same report, 2 cesarean sections were performed for relief of dystocia attributed to pelvic abnormalities. In our case series, 4 of 5 mares were determined to be candidates for elective cesarean section because of abnormalities that would cause obstruction of normal passage of the fetus through the pelvic canal. The fifth mare was admitted because of previously diagnosed cervical abnormalities. Prior to cesarean section, it was determined that the external cervical OS was free of adhesions and it was anticipated that the rest of the cervix was normal. However, further examination of the cervix was contraindicated because of pregnancy. Because of concern for potential adhesions of the cranial cervix, elective cesarean section was performed. Examination following surgery, after cervical dilation, failed to reveal any cervical abnormality. In retrospect, cesarean section may not have been required. It is reasonable however, to consider cervical or vaginal abnormalities that could obstruct passage of the fetus through the pelvic canal as indication for elective cesarean section.

Fetal maturity is of primary concern when performing elective cesarean section. Criteria established for determining fetal maturity prior to induction of parturition in mares should be used to predict proper timing for elective cesarean section. The essential indicators of fetal maturity are: (1) gestational length of more than 320 days, (2) cervical softening, and (3) substantial mammary development with colostrum in the udder. Unfortunately, length of gestation is not a reliable indicator of fetal maturity because normal gestation reportedly ranges from 305 to 400 days. In the cases reported here, gestational age was used to judge approximate time for cesarean section; however, the range was considerable (320 to 357 days) between mares. Although the limit of viability has been defined as 300 days for spontaneous delivery, it may be nearer 320 days when parturition is induced. It is conceivable that such an increased viability limit may apply to foals derived by elective cesarean section as well.

If foaling history is available, it can be used to give a rough estimate of the expected foaling date for a mare. However, this is not without risk as indicated by the case of mare 3, which attempted to deliver a foal prior to her expected foaling date and scheduled cesarean section. Furthermore, mammary development is not always a reliable indicator of impending parturition, as illustrated in the case of mare 3, which entered labor and developed severe dystocia without noticeable mammary development prior to her fourth scheduled cesarean section.

The most important indicator of readiness for parturition, for both the mare and foal, is colostrum in the udder. As parturition approaches, colostrum in the udder becomes gray or yellow-white and increasingly viscous. Ideally, elective cesarean section should not be performed until an ample supply of good-quality colostrum is in the udder. In 5 of the 8 cases reported here, mammary development and colostrum formation were judged to be adequate prior to surgery; complications did not develop in these foals. Although foal 8 appeared dysmature, the mare had adequate, good-quality colostrum. In the 3 mares that did not have colostrum in the udder prior to surgery, 2 failed to produce adequate colostrum after surgery resulting in complications in both foals and predisposing to the death of one foal. The remaining mare started producing colostrum shortly after cesarean section and complications did not develop. Unfortunately, a few mares lack substantial mammary development and fail to produce colostrum until shortly after foaling. In this situation, the chance of an unanticipated foaling predisposes mares that require elective cesarean section to severe dystocia, as in mare 3.

Electrolyte changes in mammary secretions may assist in determining readiness for birth and predicting the onset of parturition. The concentration of sodium decreases, and the concentrations of potassium and calcium increase in prepertum mammary secretions as parturition approaches. A scoring system based on these changes was evaluated in mares in which parturition was induced and the investigators concluded that a good correlation existed between mammary secretion electrolyte concentrations, fetal maturity, and readiness for parturition. In a similar study, the concentrations of calcium and the protein components of colostrum in the periparturient period were determined. In that study, one group of spontaneously foaling mares had mean prepertum
calcium concentrations of 4.1 mM/L, with mean postpartum calcium concentrations of 9.2 mM/L. It was concluded that foals less than 320 days of gestational age would have a poor prognosis for survival following induction of parturition when calcium concentrations were less than 3 mM/L. The use of rapid strip assays for predicting the onset of parturition evolved from these studies. These assays use water hardness test strips to semiquantitatively determine calcium and magnesium concentrations in a sample of prepartum mammary secretions. In cesarean section 8, mammary secretions were evaluated by a rapid strip method to determine readiness for birth. Because of the duration of gestation in this mare, determining mammary secretion electrolyte concentrations appeared helpful in predicting when parturition was imminent and cesarean section should be performed. However, it has recently been reported that the currently used rapid strip methods are not reliable for predicting impending parturition because of the variability of and times of peak concentration of magnesium in prepartum mammary secretions. It was suggested that a method that selectively measures calcium concentration would be more reliable. Further experience will undoubtedly lead to improved methods for determining calcium concentrations in the prepartum mammary secretions and give a better estimation of readiness for birth.

The ideal anesthetic protocol for elective cesarean section allows rapid induction of anesthesia with minimal adverse effects on the cardiorespiratory function of the mare and fetus. Unfortunately, currently used anesthetic or anesthetic adjuvant drugs cross the placenta, enter the fetal bloodstream, and depress the physiologic functions of the foal. One currently recommended protocol calls for induction of anesthesia with guaifenesin (60 to 80 mg/kg, IV) in combination with ketamine hydrochloride (1.5 to 2.0 mg/kg, IV), following use of xylazine (0.3 mg/kg, IV) as a preanesthetic agent. This combination of drugs proved to be successful in cesarean sections 5 through 8 of our series. Though guaifenesin alone proved satisfactory, the dosage required was excessive. The time elapsed from induction of anesthesia to delivery of the foal may be of more importance than the anesthetic protocol. The longer this critical period, the greater the uptake of the anesthetic agents by the fetus and the greater the degree of fetal depression at delivery. Our experience suggests that delivery within 20 minutes of anesthetic induction is expected to produce a minimally depressed foal. In cesarean section 8, elapsed time to delivery was 30 minutes, resulting in delivery of an anesthetized foal that required resuscitation. Another important consideration is to maximally oxygenate the mare in an effort to increase the amount of oxygen in the placental bloodstream. Insufflation of oxygen through a nasotracheal tube prior to induction of anesthesia and assisted ventilation during the anesthetic period should accomplish this goal.

Ventral midline and low flank (Marsenac) approaches have been recommended for cesarean section. Vandeplasche et al advocated a low flank approach with muscle separation for ease of animal positioning and reduced risk of postoperative herniation. In our cases, a ventral midline celiotomy was used because familiarity with this approach allowed rapid access to the abdominal cavity and an expedient and secure closure of the body wall. Furthermore, when additional exposure was needed to facilitate uterine exteriorization, the incision could be extended cranially. When using a ventral approach for cesarean section, positioning is an important consideration. With the animal in dorsal recumbency, the gravid uterus may compress the caudal vena cava, reducing venous return to the heart, which decreases cardiac output and potentially compromises uterine blood flow. This is avoided by positioning the mare in dorsolateral recumbency.

Retained placenta commonly accompanies cesarean section in the mare. With elective cesarean section, a delay in expulsion of the fetal membranes was expected because the fetus was delivered prior to entering first-stage labor. The duration of retention in our series varied from 4.5 to 72 hours, with the placenta retained for over 12 hours after of the 8 cesarean sections. Routine treatment was effective in preventing systemic complications. An important consideration is to avoid inclusion of the atlantochorion in the hysterectomy stitch of the uterine incision. In one series of cases, this contributed to retention of the fetal membranes. Separating the atlantochorion from the endometrium for a distance of 3 to 5 cm at the edges of the incision will prevent inadvertently including it in the suture line.

Delayed uterine involution and endometritis, secondary to retained placenta, and perimetrial adhesions, and uterine wall sclerosis are reported to cause decreased fertility and an increased tendency for abortion in mares following cesarean section. Conception rates of 50% with foaling rates of 35 to 40% have been reported by Vandeplassche et al. In contrast, conception rates of 80%, with the number of days from surgery to conception ranging from 58 to 458, are reported following elective cesarean section. Three of the 5 mares in our series were bred following cesarean section; however, these mares failed to conceive until the year following surgery. One mare that conceived was euthanatized for reasons unrelated to cesarean section, whereas 2 other mares conceived and carried their foals to term without complications. Mare 3 produced 3 foals in 5 years before being euthanatized for severe dystocia with her fourth foal, and mare 4 has produced 2 foals by cesarean section and is currently in foal. In both mares, uterine abnormalities were not identified during repeat elective cesarean sections. It would appear that complications such as perimetrial adhesions, uterine wall sclerosis, and markedly re-
duced fertility rates as reported by Vandeplassche et al may be related to the cause and management of dystocia during surgery rather than to cesarean section per se. However, low conception rates in the same breeding season as when elective cesarean section is performed should be expected.

Mare mortality secondary to cesarean section is most commonly attributed to uterine hemorrhage. To avoid this complication, a hemostatic stitch along the margin of the uterine incision is advocated. One investigator states that a hemostatic stitch is unnecessary if oxytocin is administered to achieve rapid uterine involution after closure of the uterine incision. We elected to use a hemostatic stitch in our cases because delayed uterine involution and expulsion of fetal membranes was anticipated following elective cesarean section.

Poor survival rates in cesarean section-derived foals are attributed to fetal hypoxia associated with rapid placental separation. Because viable foals were delivered in all cases, and probably because surgical delivery is accomplished before placental separation occurs, performing elective cesarean section appears to improve foal survivalability. For elective cesarean section to be successful, surgery should be accomplished as close to the normal time of parturition as possible. This will ensure that the foal is able to survive in the extrauterine environment and the mare can provide adequate passive immunity and nutritional support. Furthermore, good-quality donor colostrum should be administered to the foal soon after delivery to provide nutritional support until the mare has recovered from anesthesia and to ensure adequate passive transfer of immunoglobulins.

References


