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Reproductive surgeries: why necessary and what to perform for specific problems

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Abstract

In mares, causes of infertility and subfertility are often multifactorial. Numerous congenital, pathological, and neoplastic conditions affecting the reproductive tract have been associated with decreased fertility. Despite a clinician's best attempt to resolve or improve fertility through medical management, incorporation of an appropriate surgical technique is often indicated. Reproductive surgeries are often necessary to address underlying anatomical abnormalities or eliminate pathological conditions negatively affecting mare fertility. The main goal of any reproductive surgery should be to improve, restore, or protect a mare's future fertility. This review will focus on the importance of surgical intervention in the chronically infertile mare.

Keywords: Reproductive surgery, pregnancy, uterus, mare, infertility

Introduction

Reproductive surgeries are generally elective but no surgery is without risk. As such, a complete breeding soundness evaluation (BSE) and a thorough review of the mare's breeding history are warranted prior to surgery. The BSE should include transrectal palpation and ultrasonography of the reproductive tract, vaginal speculum examination, digital cervical palpation, endometrial culture and cytology, and an endometrial biopsy. A BSE not only aids in identifying factors associated with infertility, but results of endometrial biopsy may also offer a prognosis for future fertility. This is an important consideration, as preexisting degenerative changes to the endometrium are irreversible and associated with a poor prognosis of overall fertility, making the reproductive surgery futile. Reviewing a mare's reproductive history helps to ensure that the cause of infertility cannot be attributed to stallion effect, inappropriate breeding management, endometritis or degenerative changes in the endometrium. In cases of unexplained infertility, additional diagnostic techniques including hysteroscopy, laparoscopy, and hormone assays may be considered to ensure that further reproductive surgical procedures are not performed unnecessarily. The aim is to describe common clinical conditions unresponsive to medical management and further highlight diagnostic approaches and surgical treatment options.

Caudal reproductive tract

Pneumovagina

The 3 natural physical barriers from the caudal reproductive tract to the uterus are the vulva, vestibulo-vaginal sphincter, and cervix. The vulva and vestibulo-vaginal sphincter represent the primary anatomical protection from uterine infection.[1] Any alternations in perineal conformation or disturbances in the natural anatomical uterine defense mechanisms can be detrimental to reproductive performance. Incompetence or a breach in 1 or more of these barriers may arise via effects of genetics, age, body condition, parity, and trauma.[2] Loss of the airtight vulvar seal or compromise of the vulva or vestibulo-vaginal sphincter predispose the mare to pneumovagina. Consequently, pneumometra, inflammation, and infection resulting in acute or chronic endometritis are common sequelae that are unlikely to respond to medical treatment unless the underlying anatomical problem is corrected.

Diagnosis of pneumovagina involves visual and functional evaluation of the perineum and vestibulo-vaginal sphincter. Perineum includes anus, vulva, and adjacent skin including perineal body. Normal labia are full and firm and meet evenly on the midline, with 80% or more of the vulvar opening positioned below the pelvic brim.[3] Excessive vulvar length above the pelvic brim and an increased angle of declination decreases coaptation of the vulvar labia. If separation of the labia elicits an audible sound there is evidence of incompetence. Observation for aspiration of air and transrectal ultrasonography can be used to further confirm the presence of air within the vaginal cavity and potentially within the uterine lumen. Poor perineal conformation may be exacerbated during estrus or pregnancy as the weight of the gravid uterus may alter the external anatomy.

Multiple surgical approaches have been described to treat pneumovagina, based on the severity of the condition. Vulvoplasty or the Caslick's operation, is the oldest and most common reproductive surgery performed to prevent air aspiration and contamination of the reproductive tract.[4,5] Caslick's procedure involves removal of a mucosal strip from the labial margin and suturing the apposed tissues, resulting in formation of a permanent airtight seal.[2] Temporary approaches utilizing staples, super glue, and suturing the vulvar labia without the removal of a mucosal strip have also been described but are often ineffective. A breeding suture may be placed to protect the integrity of the Caslick's during reproductive procedures. Fistula formation and dehiscence may occur, especially in older mares with tissue fibrosis.[2]

Perineal body reconstruction, also referred to as an episioplasty or a Gadd's procedure, is utilized when Caslick's fails to resolve the pneumovagina due to insufficient perineal body tissue or vestibulo-vaginal sphincter incompetence.[2] Perineal body is the musculofibrous shelf of tissue between the floor of the anus and the roof of the vestibule; its integrity can be compromised via foaling trauma or repeated stretching of the vulvar and vestibular constrictor muscles in older multiparous mares.[6] Diagnosis of a weak or torn perineal body is by digital palpation. Although 4 - 8 weeks' sexual rest following episioplasty is recommended to allow for adequate healing, the procedure can be successfully performed on the day of ovulation in the at-risk breeding mare.[7]

Perineal body transection, or the Pouret's operation, is reserved for mares with extremely poor perineal conformation and in which pneumovagina fails to resolve following vulvoplasty or episioplasty.[2] Advanced age and increased parity exacerbate the degree to which the anus sinks, pulling the vagina cranially and the vulvar labia above the pelvic brim.[2] Perineal body transection frees the attachments between the rectum and the dorsal vaginal vault, minimizing the pull of the sunken anus on the vagina and restoring the vulva to a more normal vertical position.8 Modification of Pouret's technique incorporates a horizontal suture to correct pneumovagina; 3 this modified technique substantially improved vulvar coaptation, perineal position, and reproductive outcomes in 14 of 18 mares. Authors suggest that artificial insemination may be performed immediately postoperatively, whereas natural breeding may occur within 3 weeks after surgery.[3,8]

Unfortunately, a Caslick's or Gadd's procedure often require the surgery to be repeated for the duration of the broodmare's career. Severe perineal tearing may arise if an episiotomy or the dorsal vestibule are not opened prior to foaling.[2]

Vesicovaginal reflux

Failure of the mare to completely void urine results in vesicovaginal reflux (VVR) or urine pooling. Urovagina or urometra is accumulation of urine in the cranial vagina or uterus, respectively. Normal outflow of urine is inhibited when the cranial vagina slopes cranioventrally. Age-related changes, poor body condition, foaling trauma, excessive Caslick's length, and incorrect vulvoplasty have been identified as predisposing factors.[9,10] Detrimental effects on fertility are multifaceted and persistent urine contamination may reduce the mare's ability to conceive or carry to term. Continual contact with urine can lead to local tissue inflammation, endometritis, or have a noxious effect on sperm.[11-13]

A definitive diagnosis is easily achieved when urine is visualized in the vaginal fornix via vaginoscopy. However, urine pooling may be intermittent in some mares and depends on the tone of the reproductive tract that is cyclically altered under the influence of estrogen.[14] Although repeat examinations during estrus have been suggested to aid in the diagnosis, measuring intrauterine fluid creatinine concentration is an objective means of diagnosing urometra.[14,15] In the postpartum mare, urine pooling may be transient and self-limiting for up to 30 days postfoaling.[14] In cases of infertility in which urine pooling has been diagnosed, or in postpartum mares that continue to experience urometra, a urethral extension surgery may be indicated.[14] A presurgical reproductive evaluation that includes endometrial biopsy is recommended, as chronic urine pooling is associated with periglandular fibrosis.[14]

The goal of any of the described surgeries to manage VVR is to reduce the potential for cranial movement of urine. In mild cases of VVR, caudal relocation of the transverse fold has been described and may be indicated for mares with minor conformational deficiencies or estrogen-induced transient relaxation of the reproductive tract.[9] However, relocation of the transverse fold is often only temporary and may be contraindicated in mares with significant conformational issues.[13] A recent technique16 involves injecting polyacrylamide hydrogel into the transverse fold, thus creating a bulge that remained palpable for up to 60 days postinjection. Authors suggest that bulking up the surrounding tissue may serve as an alternative to surgery in mild cases of VVR.[16]

The more traditional approach to surgically correct VVR is creation of a urethral extension to transport urine further caudally before expulsion from the urethra. There are numerous surgical techniques describing formation of a tubular tract from the vestibular mucosa.[6] Regardless of the technique, caudal urethral extensions are prone to the development of fistulae and mares should be assessed approximately 2 weeks postoperatively[13,17] Although surgery is often delayed to the end of the breeding season, mares may be bred in the same estrous cycle as surgery and have adequate pregnancy rates.[17]

Cervical trauma

Cervix is the third and most cranial anatomical barrier to the uterus. In diestrus and in pregnancy, under the influence of progesterone the cervix forms a seal protecting the uterus from the external environment and ascending infection. Cervical

lacerations may occur when cervix fails to sufficiently dilate during foaling, abortion, or dystocia. Excessive stretching of the muscular layer of the cervix during foaling may result in cervical incompetence.[18] Cervical trauma may predispose the mare to chronic endometritis and infertility.[18] Mares able to achieve pregnancy early may fail to carry the foal to term as cervical incompetence increases the risk of ascending placentitis or abortion.[19]

When a cervical laceration is suspected, evaluation should be performed while the mare is in diestrus with maximal cervical tone. Visual assessment is often unrewarding and manual palpation is required to make an accurate diagnosis. Circumferential palpation of the cervix is performed by inserting the index finger into the cervical lumen and the opposing thumb on the vaginal side of the cervix.[20] Palpation of each lateral half of the cervix may identify adhesions, thinning of the fibromuscular layer, or full-thickness defects in the cervical wall, and allow for estimation of defect length.[18,20,21] Not all cervical lesions require surgical repair. Small lesions may be incidental allowing mares to conceive and proceed with an uncomplicated pregnancy. Surgical intervention is indicated in mares with a history of infertility and an appreciable cervical defect or lacerations involving 50% or more of the vaginal cervix.[20] In a retrospective analysis of surgical outcomes of mares diagnosed with cervical lesions, 61.9% of mares that underwent surgical repair delivered a live foal compared to 48.4% of mares that did not have surgery. This study also demonstrated that rapid diagnosis and earlier surgical intervention improved live foal outcome.[22]

Surgical approach to cervical defects is based on surgeon preference and lesion location.[18,23] If multiple defects exist, individual repairs should be staged 3 - 4 weeks apart.[21] Surgery is performed during diestrus to improve visualization of the defect margins.[18] Alternatively, surgery may be performed under the influence of supplemental progesterone or several days post-breeding in an effort to maintain breeding efficiency.[18] Postoperative complications are rare, but adhesions within the cervical lumen, stenosis, uterine infections, and cervical incompetence have been reported.[18,24]

Four weeks of sexual rest is recommended before rebreeding. Artificial insemination is favored if permitted by the breed registry; otherwise, a breeding roll should be incorporated for natural cover to minimize possible trauma.[24] Although surgical correction improves cervical integrity, lesions heal by fibrosis and as such, the elasticity of the tissue is permanently reduced.[25] Consequently, an estimated 20 - 50% of surgically corrected cervical tears may require a subsequent surgery postfoaling.[18,20,26] A recent report[26] identified decreased foaling rates with each successive surgery.[26]

In cases of cervical incompetence, a cervical cerclage suture in late pregnancy improved cervical function, decreased the risk of ascending placentitis and strengthened the cervix against mechanical forces.[19] Although no complications were reported, cervical damage may occur if the mare delivers with the suture in place.[19]

Oviductal lesions

Salpingitis, hydrosalpinx, neoplasia, adhesions, cysts, and oviductal blockages have been described in the mare. Postmortem studies have revealed an array of lesions affecting the oviduct. In most cases, however, the presence of a lesion could not be related to a distinct negative effect on fertility.[27] Oviductal abnormalities in the mare are rare but should be considered when all other potential causes of subfertility or infertility have been excluded.

Confidently diagnosing oviductal pathology is often difficult, as most lesions affecting the region go undetected using conventional methods. Although transrectal palpation and ultrasonography offer limited diagnostic value for most oviductal abnormalities, they have aided in the diagnosis and monitoring of fimbrial, paraovarian, or uterotubal cysts.[27] An investigation should include a thorough review of the breeding history. Failure to achieve pregnancy associated with 1 ovary would support a presumptive diagnosis, and laparoscopic investigation may then aid in the definitive diagnosis of oviductal abnormalities. At present, the majority of cases of suspected oviductal pathology are based on diagnosis by exclusion.

In the past decade, credence has been given to oviductal blockages as a cause of mare infertility. Although experimental methods have been described to assess oviductal patency, in a clinical setting, suspected oviductal blockage is often a diagnosis of exclusion.[28,29] Techniques described to resolve the presumptive condition include catheterization of the oviduct via laparotomy, laparoscopic application of prostaglandin E2 (PGE2), hysteroscopic hydrotubation, and deep-horn application of misoprostol (PGE1) to the oviductal papillae.[30-34] Laparoscopic application of PGE2, hysteroscopic hydrotubation, and deep-horn application of PGE1 are the most widely accepted techniques. In a study, 93% (14/15) of mares with unexplained infertility conceived in the same or subsequent breeding season following laparoscopic application of PGE2 to the oviduct.[31] Hysteroscopic hydrotubation technique involves insertion of a catheter into oviductal papilla and flushing them with sterile saline in a retrograde direction;32 92.8% (26/28) of previously barren mares conceived after treatment during estrus or diestrus.[35] Application of PGE1 to the tip of the uterine horn lumen using a deep-horn insemination pipette, during diestrus in a subset of barren mares resulted in 68% (15/22) conception within 2 estrous cycles after treatment.[33] There was no significant difference in pregnancy rates between laparoscopic PGE2 application and oviduct hydrotubation.[36]

Although pregnancy outcomes attained after these treatments suggest an improvement in fertility, each technique has associated risks and variable costs. Laparoscopic approaches carry the inherent risks and increased costs of surgery, as well as the cost of the PGE2. In addition, postoperative stall rest may be a

limitation for some clients. Although hydrotubation avoids surgery, iatrogenic damage to the oviduct and endometritis secondary to hysteroscopy are important considerations. Despite increased risks and potentially higher costs, endoscopic approaches may offer some diagnostic advantages over the minimally invasive deep-horn application of PGE1. The hysteroscopic hydrotubation approach enables visualization of the uterus and may identify uterine pathologies that were previously undiagnosed.[37] A major advantage of the laparoscopic approach is that it allows for direct visualization of the oviductal region.[37,38] This approach may aid in the diagnosis of adhesions, neoplasia, cysts, or other lesions that may be the suspected cause of infertility. Adhesions, large cysts, and acquired abnormalities may disrupt the normal anatomy and function of the oviduct. Surgery can be attempted to restore anatomy and improve function. In a small subset of mares, after transection of restrictive bands of the mesosalpinx and laparoscopic PGE2 application, 89% (8/9) of previously barren mares conceived and 78% (7/9) of these mares also conceived the following year.[39] If a lesion is inoperable or neoplasia is suspected, unilateral ovariectomy may be warranted to improve breeding efficiency.[27] In breeds in which ovum pick-up is permitted, the affected ovary may be left in place and this technique considered as a method to obtain embryos.

Uterine Pathologies

Endometrial cysts

Endometrial cysts are generally considered nonpathological and simply a nuisance complicating pregnancy diagnosis. However, cysts may be associated with decreased reproductive performance. A significant difference was observed comparing seasonal pregnancy rates at days 14 and 40 for mares with cysts (77.6 and 71.4%) to a cohort without cysts (91.5 and 88.0%).[40] The presence of cystic lesions represents underlying degenerative endometrial changes. The physical effects of endometrial cysts may impede uterine clearance, interfere with embryo migration, and inhibit normal embryonic development and placentation.[41] Early embryo loss has occurred when the conceptus was fixed adjacent to a cyst and uterine contact was limited.[42] Cystic regions inhibited microcotyledon development resulting in avillous lesions on the chorioallantois.[43]

The most common method of diagnosing endometrial cysts is transrectal palpation and ultrasonography. Ultrasonographic appearance of cysts ranges from individual, discreet, solitary lesions to multiple, irregular-bordered, multicompartmental structures. Infusion of a sterile solution into the uterus creates a contrast enabling transrectal ultrasonography to differentiate between luminal and mural cysts.[41] Hysteroscopy can be used to ascertain the specific location of the cysts.

Endometrial cyst removal has improved fertility in some mares.[44-47] Several techniques have been described including manual ablation, puncture, fine-needle aspiration, mechanical rupture, hysteroscopic guided electrocautery, and laser therapy.48 However, no clinical comparisons of treatment options and outcomes have been reported.

Manual ablation or mechanical rupture of cysts is performed during estrus or postpartum. Cervical dilation must be sufficient to facilitate passage of the instrumentation and the operator's hand. Manual rupture is performed by placing the cyst between 2 fingers and tearing or crushing the cyst off the uterine wall.[48] Mechanical rupture is accomplished by ensnaring the cyst with suture or embryotomy wire and sawing through the base of the tissue.[49] Alternatively, the stalk of pedunculated cysts may be transected with endometrial biopsy forceps.

Hysteroscopic guided electrocautery and laser therapy have been described.[44,45,50,51] This approach offers the benefit of direct visualization of cysts and possible identification of concurrent pathology.[37,50] It is suggested that electrocautery is utilized for larger pedunculated cysts whereas laser therapy is reserved for smaller or nonpedunculated cysts.[41] The hysteroscopic procedure is best performed during diestrus as a tight cervical seal improves uterine distension. Based on clinician preference, the uterus is insufflated with air or distended with sterile fluid to allow passage of the endoscope through the uterine lumen.

Recently, a technique involving ethanol sclerotherapy as a potential alternative was described. Endometrial cysts were emptied endoscopically, and 70% ethanol in saline solution was injected to fill 40% of the original volume.[52] The suggested mechanism of action is that ethanol strips the inner layer of the cyst, inducing thrombosis of small vessels and coagulative necrosis followed by fibrosis.[52] Following this treatment, 87.5% (6/7) of chronically infertile mares achieved a pregnancy and delivered a foal.

Regardless of the technique utilized, any residual cystic tissue should be removed, and serial uterine lavage should be performed until the efflux is clear. Concurrent use of antibiotics is warranted in select cases. Although hemorrhage and endometritis have occasionally been associated with the procedure, recovery is rapid and pregnancy can be achieved on the same cycle as cyst removal. It is important to note that preexisting underlying uterine pathology increases the incidence of new cyst development.[41] Therefore, the author suggests that the procedure should be performed in preparation for the season; otherwise, owners should be made aware of the potential for recurrence.

Pendulous uterus

The normal orientation of the mare's uterus is horizontal and above or level with the brim of the pelvis. With increased age and parity, the mesometrium is repeatedly stretched resulting in an increasingly pendulous uterus with a ventral slope in relation to the pelvis. Often, as the uterus slopes ventrally, the rectum and vagina are pulled cranially resulting in a sunken anus and poor perineal conformation. As a consequence, the

ventrally oriented uterus lends itself to an increased risk of contamination, delayed uterine clearance, and chronic endometritis.[53] As a recognized cause of infertility in the older mare, a ventrally sloping uterus can be problematic and challenging for clinicians.[54]

The workup for these mares is relatively straightforward; detection of a pendulous, ventrally sloped uterus via transrectal palpation should confirm the diagnosis. Clinical indications include the lack of fluid resolution despite appropriate intensive management. An endometrial biopsy should be performed as a prognostic indicator.

Uteropexy, laparoscopic imbrication of the mesometrium, was attempted to improve uterine clearance.[55] The surgical technique confirmed that the orientation of the pendulous, ventrally sloping uterus could be restored to a more horizontal position.[55] In addition, uterine assessment via transrectal palpation and ultrasonography demonstrated a subjective reduction in the overall size of the uterus postoperatively. Laparoscopic assessment revealed that newly formed adhesions between the mesometrium and uterus supported the horizontal uterine position.[55] An improvement in perineal conformation was also noted. Use of barbed suture for mesometrial imbrication resulted in similar postoperative changes; however, the study did not confirm whether adhesion formation occurred.[56]

Laparoscopic uteropexy appears to produce favorable outcomes in chronically infertile mares. Pregnancy rates from cases with available follow-up data from 2 studies were 47% (9/19) and 67% (2/3), respectively.[55,56] Unfortunately, effects on future fertility are unclear, due to the lack of published information and case-controlled studies. The recommended interval from surgery to rebreeding is variable amongst reports. In many cases, the chronicity of the disease would suggest that prolonged sexual rest is warranted and may optimize outcomes. This hypothesis was supported;[56] 2 mares that became pregnant after uteropexy conceived on their first cycle after sexual rest for 6 and 7 months, respectively.[56] Pioneers of uteropexy caution that despite improving uterine clearance, preexisting endometrial fibrosis may impair the ability of the uterus to support and maintain a pregnancy to term.[57] In cases with poor endometrial biopsy scores, uteropexy may be beneficial to restore fertility through embryo transfer, if permitted by the breed registry.

Despite minimal to no intraoperative or postoperative complications being reported, the author has experienced a case with significant post-operative complications. The mare was presented for an abscess draining from the paralumbar fossa after uteropexy. Additional investigations revealed that the abscess extended medially, involving the reproductive tract. Stenosis of the right uterine horn, luminal intrauterine adhesions, adhesions between the uterine horn, ovary and body wall and paraovarian abscessation of the right ovary were all appreciable.

Uterine anomalies

Complete ovariohysterectomy is generally reserved as a salvage procedure to improve a mare's quality of life when reproductive conditions fail to respond to conservative medical management. The most commonly reported indication is chronic pyometra.[58] Unfortunately, ovariohysterectomy results in sterilization.

Congenital anomalies, focal uterine tumors, uterine hematomas, uterine adhesions and ovarian masses with associated uterine horn adhesions are all causes of mare infertility. It is hypothesized that the negative effects on fertility of these conditions may be the result of alterations in uterine environment, uterine horn obstruction, or their combinations. Endometritis is often associated with uterine tumors, and uterine horn obstruction may interfere with fertilization, embryo migration or embryo implantation.[59] In many cases a presumptive diagnosis is made via transrectal palpation and ultrasonography. Some authors have suggested that hysteroscopy may be a valuable tool to aid in the diagnosis of these conditions.[59,60]

In select cases, partial hysterectomy may be an option to improve fertility. Although the exact amount of uterine tissue required to maintain an equine pregnancy is unknown, in rare cases of uterus unicornis, pregnancy was attainable and maintained, resulting in successful delivery of foals.[61-63] Authors have reported pregnancies in chronically infertile mares following the removal of uterine masses via partial ovariohysterectomy.[64-68] Successful pregnancy and live foaling were reported60 after a partial ovariohysterectomy that addressed a congenital abnormality, suspected as a cause of infertility.[60]

The standing laparoscopic approach to partial ovariohysterectomy is minimally invasive with few reported complications. The time to rebreeding was variable amongst case reports. One mare conceived 60 days after surgery, whereas the majority of mares were bred the following season. In a mare, pregnancy was not identified over 3 estrous cycles and she subsequently became an embryo donor.[68] In addition, authors have reported that fertility may be permanently restored and several mares have produced multiple foals following surgery.[60,65]

Cesarean

Cesarean section or C-section is most commonly performed in an emergency situation to resolve a dystocia when vaginal delivery cannot be achieved. It is a true surgical emergency that should proceed rapidly and efficiently. The longer the interval between the rupture of the chorioallantois and resolution, the lower the probability of foal survival.[69]

C-section may also be successfully utilized as an elective procedure when natural delivery is deemed undesirable. Candidates for an elective C-section include conditions that may compromise the birth canal or when natural delivery is life-threatening or endangers the future fertility of the mare. Chronic pelvic fractures,

cervical adhesions, vaginal fibrosis, previous surgical repair of the cervix, partially ruptured prepubic tendon, hepatic lipidosis, previous history of dystocia, and uterine artery hemorrhage have all been indications for elective C-section.[69-73] Authors have reported favorable outcomes for both mare and foal survivability. Of the reports reviewed, 100% of mares undergoing going elective C-sections survived to discharge and some have undergone subsequent successful elective C-sections.[69-73] The author has experience with a mare having successfully undergone 5 elective C-sections. More than 90% of foals survived to discharge after elective C-section compared to < 30% of foals surviving after emergency C-section.[69-73] In addition to complications associated with abdominal surgery, retained fetal membranes is the most commonly reported complication following elective C-section.[70]

Timing of the elective surgery is crucial to ensure that a viable foal is produced. It has been well documented that pregnancy length cannot be used to determine fetal viability.[74] The author has reviewed clinical cases in which 8 elective C-sections were performed with concurrent gastro-intestinal disease; in these instances, mammary secretions were not assessed and despite all mares being at least day 330 of pregnancy, foal survival to discharge was 0% (McNaughten, unpublished data). Early reports based the timing of surgery on common signs of impending parturition such as physical status, udder development, softening of perineal tissues, and behavior.[75] However, the author feels that these measures are subjective and may be misinterpreted. Fetal readiness prior to elective C-section was determined[72] according to the presence of colostrum in the udder and all mares and foals survived to discharge. In a normal mare, changes in the composition of mammary secretions (such as calcium concentration and pH) remain the most reliable predictor of foal readiness and impending parturition, can be readily measured and should be utilized prior to elective C-section to improve foal survival.[76-79]

Conclusion

Causes of infertility and subfertility tend to be multifaceted and are often unresponsive to medical management alone. Reproductive surgeries are often necessary to improve reproductive outcomes in chronically infertile mares. Complete breeding soundness evaluation is warranted prior to surgery to ensure an accurate diagnosis and favorable postoperative prognosis for future fertility. Early diagnosis and rapid implementation of the appropriate surgical procedure offer an immediate benefit and improve the future prognosis of the mare.

Conflict of interest

There are no conflicts of interest to declare.

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