Intra-partum conditions and their management in mare

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Abstract

Intra-partum conditions in the mare include premature separation of the allanto-chorion, failure to lie down or strain uterine inertia and dystocia. Dystocia in the mare is a rare event but a true emergency when it occurs. Because of the long extremities and the strong contractions that occur during parturition malposture of a long fetal extremity or head deviation is the commonest cause of dystocia in the broodmares. Although many other fetal causes of dystocia have been described they appear to be much less frequent. Maternal causes like uterine torsion, uterine inertia and conditions causing constriction of the birth canal are infrequent in the mare. The approaches to handle dystocia in the mare described recently include assisted vaginal delivery, controlled vaginal delivery, fetotomy and cesarean section but dystocia handling for complicated cases in the mare requires specialist hospital facilities and a team of experts. The preparation of mares for normal foaling, various intra-partum conditions, short and long term anesthesia, the various causes of dystocia and their handling are described.

Key Words: Cesarean, dystocia, fetal, fetotomy, mare, maternal,

Introduction

The gestation period in the mare is stated to be 340 days, but foals with delayed development may be born normally up to 385 days (Youngquist, 1986; Davis Morel et al., 2002). Some mares may foal prior to 315 days (Hungerford, 1990; Davis Morel et al., 2002). Gestation length in the donkey mares varies between 10½ to 14½ months (Kirby, 1989). The mare appears to have the ability to exercise some control over the onset of labor and most foals are born (Youngquist, 1986; Purohit *et al*., 1999) when stable activity is at the minimum. Donkey mares can however, foal during day or night hours. The signs of an impending parturition are less marked in the mare compared to cattle. In late gestation slight relaxation of the sacrosciatic ligaments occur but may not be very visible due to heavy croup muscles. The udder develops during the last 1 to 1½ months and waxing may be seen 24 to 48 hours before foaling in most, but not all mares (Frazer *et al*., 1999a). Udder swelling appears at 3 weeks before foaling and the teats become distended 72 hours before foaling in donkey mares (Kirby, 1989; Purohit, 2004). The mammary secretion electrolytes change dramatically before foaling (Peaker *et al*., 1979) and are the basis of commercial kits available over many countries to predict foaling time (Cash *et al*., 1985). One to four mL of milk is taken from mares daily and tested for the electrolyte concentration specially calcium and magnesium, which increase abruptly before foaling. If calcium and magnesium do not increase the mare is not to foal within 24 hours. However, these electrolyte changes are not a reliable indicator of fetal maturity, if a placental anomaly (plancentitis, twins) is present (Frazer, 2007).

Foaling in the mare is a violent and short process with the birth of foal completing within 30 minutes to 70 minutes following the rupture of chorioallantoic membrane. The first stage of labour is characterized by sweating and frequent urination that last for 15-90 minutes. During delivery it must be remembered that the outer surface of the chorion is deep red in colour and has a velvety appearance whereas the amnion is opaque blueish white with the fetal parts not clearly visible as in cattle. The onset of second stage of labor occurs abruptly. It is characterized by appearance of the water bag or commencement of forcible straining. Very soon the mare goes down and there is appearance of fetal leg. One fetal leg is around 6 inches ahead of the second leg till fetal delivery (Benesch and Wright, 2001). The umbilical cord is intact when the foal is born. It ruptures by the movement of mare or foal. Looking to the strong forceful contractions that occur during delivery of a foal, the rapidity of fetal delivery, the pressure of saving the life

of mare and foal both due to high costs, early placental separation and the complications that may follow in a poorly attended or unattended difficult delivery in a mare it is suggested that obstetricians must attend intra-partum conditions that occur in a mare on priority. A coordinated dystocia management protocol (CDMP) has been instituted at some places (Norton *et al*., 2007; Wilkins, 2008) to resolve dystocia on priority. Overall a good working team and referral facilities are necessary to deal with equine dystocia. Intrapartum conditions in the mare have been reviewed under the following sub-headings:

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3. Intrapartum conditions in broodmares

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1. Preparation of mare for normal foaling

The preparation of mare for foaling has been widely described (Blanchard *et al*., 1998). Recent literature (Riddle, 2003), however, throws some important insights which are briefly summarized:

1. Till the last month of gestation, mares must be left out 24 hours/day except for feeding in the stall twice a day or in inclement weather.
2. It is suggested to put pregnant mares under artificial lights (60 W incandescent bulbs) from December 1. This would decrease the length of gestation by 7-10 days permitting more time to breed the mare in the breeding season. This would also decrease the likelihood of postpartum anestrus (Daels and Hughes, 1998).
3. Enter mares into foaling barn 30 days before expected foaling date with a turn out in paddocks of 6-8 h/day.
4. Open *caslicks* sutures, when signs of waxing appear or 2 weeks before expected foaling date. Apply petroleum jelly daily to vulva after suture opening.
5. Near foaling, monitor mares twice a day for vulvar discharge and udder development.
6. Mares with premature udder development should be monitored for total estrogens. Levels between 500 and 800 ng/ml indicate a compromised fetus. Such mares should be given altrenogest (0.088 mg/kg), pentoxifylline and systemic antibiotics. A decline in estrogens below 500 ng/ml is an indication of impending abortion in most cases.
7. Vaccinate mares for prevalent disease. Tetanus vaccine must be given 60 days before foaling and immediately after foaling (Tetanus Antitoxin 1500-3000 I.U S/C or Tetanus Toxoid 2-6 ml S/C or IM). Likewise, rabies and encephalomyelitis vaccines must be given 60 days before expected foaling date. Equine Herpes virus (modified live vaccine EHV-1 or killed vaccine for EHV-1 and EHV-4) vaccination must begin at 4-5 months and then repeated every 2-3 months.

2. Fetal orientation during pregnancy and parturition

The equine fetal orientation during gestation appears to be a complex process. The equine amnion floats freely within the allantoic fluid. Fetal mobility is maximal during the third and fourth months of gestation and then decreases over the next four months, possibly due to decreased space within the uterine lumen as the fetus grows (Ginther and Griffen, 1993; Ginther *et al*., 1993). During late gestation, the caudal aspect of the fetus is intimately associated with the uterine wall; the cranial portion has room to rotate within the uterine body itself (Frazer, 2001a). Studies have demonstrated that the full term equine fetus is initially lying in a dorso pubic position with the head, neck and forelimbs flexed (Jeffcott and Rossdale, 1979). The increasing uterine tone during stage-I of parturition stimulates the fetus to extend its head and forelimbs (Ginther, 1998). Rupture of the chorioallantois and passage of the allantoic fluid does not occur until the fetlocks or knees are at the level of the external cervical opening (Frazer, 2001a). As the nose reaches the vulva the cranial half of the fetus rotates from a *dorsopubic* to *dorsoilial* position (Ginther, 1998). The foals' withers continue to rotate into a dorso sacral position as the head appears through the vulvar lips. The fetal pelvis rotates as the hips pass through the vulva (Frazer, 2001a). Axial rotations of 90° involving the cranial aspect of th fetus together with head-neck postural changes, are common in late gestation in the mare (Frazer, 2001a).

3. Intrapartum conditions in broodmares

The intrapartum conditions that occur in the broodmare have been described (Higgins and Wright, 1999) to be premature separation of the allanto-chorion, failure to lie down, failure to strain uterine, inertia and dystocia.

3.1 Premature separation of the allanto-chorion

This is seen in mares occasionally and considered an emergency. The chorion separates prior to rupture at the cervical pole. The membrane is presented as intact velvety red sac at the vulvar lips. It is sometimes called *Red Bag* condition. Rapid manual rupture and assisted delivery are suggested to save the foal (Higgins and Wright, 1999), as the foal is in immediate threat of suffocation. The condition is also seen in pony mares and miniature horses (Rossdale and Jeffcott, 1975).

3.2 Failure to lie down

Mares may remain in standing position, particularly if they are disturbed by attendants. This can be avoided if mares are observed without their notice. Mares may also avoid lying down if they have musculo-skeletal problems or due to a nervous excitable disposition (Dugdale, 2007). Some mares may have a repeated history of this behavior without any obvious underlying cause (Dugdale, 2007). Under such

conditions, mare should be restrained and the foal supported to prevent injury and premature rupture of the umbilical cord. Traction may be usually needed, as contractions are less forceful in a standing position.

3.3 Failure to strain

A mare with heart, chest or orthopaedic problems may be too uncomfortable during the second stage labour and may not complete delivery because of reduced or failed abdominal contractions. Such mares need prompt external assistance. This can vary in degree and may be related to a circulatory, respiratory, abdominal or orthopedic problem. A condition seen at foaling which lead to very weak contractions is the rupture of caecum or colon due to a blow from the foal's foot (Dugdale, 2007). Signs of colic are often minimal in these cases. Whatever, the cause, foaling should be aided by controlled traction.

3.4 Uterine inertia

This unusual condition is commonly seen in primiparous mares. The mare is comfortable during the first stage labor with a relaxed cervix but does not initiate second stage (Frazer et al., 1997b). Parturition can be induced with 5-15 IU oxytocin administered in 1 liter of saline by IV drip usually without complication (Youngqnist, 1986). The condition is considered primary if it occurs due to disturbance or nervousness. This can be resolved by avoiding disturbance and giving oxytocin. Uterine inertia is considered secondary if inertia occurs due to exhaustion following attempts to deliver a maldisposed fetus. In such cases the maldisposition should be corrected first followed by assisted vaginal delivery.

3.5 Dystocia

Dystocia is defined as any birth that reduces neonatal viability, causes maternal injury, or requires assistance (Faheming *et al*., 1997; Frazer *et al*., 1997a; Purohit and Honnappagol, 2009).

Dystocia in the broodmare occurs less frequently compared to other domestic animals, but when it occurs it is considered one of the true emergencies that equine practitioners encounter, where minutes makes a difference in the survival of one of the patients (Giles *et al*., 1993; Haas *et al*., 1996; Mc Gladdery, 2001; Embertson, 2003; Lu *et al*., 2006 Norton *et al*., 2007; Wilkins, 2008). Since majority of mares foal during the night hours (Purohit *et al*., 1999) the obstetrician may be called, or the mare referred to the referral hospital at odd hours. Dystocia is one of the challenging intrapartum conditions for the equine practitioner. Dystocia must be suspected if the first stage of labor is very long or foal not born in 20-30 minutes of rupture of fetal membranes and release of fluids. Dystocia is less frequently reported for the miniature pony mares (Judd, 1994; Neves *et al*., 2009) and feral equids like zebra (Kloppel, 1991; Boos *et al*., 1975).

3.5.1 Incidence

The incidence of dystocia varies among breeds, with the incidence in Thoroughbreds approximating 4% (Frazer, 2001a). However, in the author's experience dystocia is extremely rare. Between 1993 – 1996 (Purohit *et al*., 1999) and 1997 – 2008 (Observations at the same stud farm), there was no single case of dystocia for the 64 and 143 foalings respectively at a thoroughbred stud. In breeds like Belgian draught horses and Shetland ponies the incidence is known to be high upto 10% (Swendsen, 1989; Vandeplassche, 1992). A high propotion of the dystocia occur in primiparous mares (Ginther and Williams, 1996; Frazer *et al*., 1997b; Ball, 2005) and donkey mares (Swendsen, 1989). Ponies are more likely to experience difficulties due to a large fetal skull (Vandeplasche , 1992).

3.5.2 Causes of dystocia

Malposture of the long fetal extremities is the major cause of dystocia in the mare (Vandeplaccshe, 1987; Frazer *et al*., 1997b) although positional and presentational abnormalities also occur but to a lesser degree. Many, but not all of the causes for dystocia in cattle are seen in the mare and classically, the causes for dystocia in the mare are divided into **maternal** and **fetal** causes (Roberts, 1986; Threlfall, 2007), although the maternal causes are not common.

(a) Maternal Cause:

The maternal causes of dystocia described for the mare include the obstruction of the birth canal and failure of the expulsive forces. The obstruction of the birth canal can result because of vaginal/cervical strictures, vaginal tumors and varicose veins (Jackson, 2004) although the most frequent cause of obstruction is uterine torsion (Wichtel *et al*., 1988; Sertich, 1994; Chaney *et al*., 2007; Lopez and Carmona, 2010). The causes of failure of the expulsive forces include abdominal hernias/prepubic tendon rupture (Auer *et al*., 1985; Hanson and Todhunter, 1986; Frazer *et al*., 1997b; Ross *et al*., 2008), maternal dropsical conditions (Blanchard *et al*., 1987; Honnas *et al*., 1988) and uterine inertia.

Obstruction of the birth canal by pelvic fractures/exocytoses is uncommon and breeding should be avoided from such mares. Vulvar strictures can occur subsequent to a *Caslick's* operation. Tumours of the

Table 1. Incidence of equine fetal maldispositions in various reports.

Maldisposition	Incidence	Reference
Bilateral carpal flexion with other deformity most common	-	Nimmo *et al*., 2007
Transverse	18% (Draft breeds) 8% (Light breeds)	Frazer *et al* 1997b
Malposture Anterior presentation Post presentation	86% 68% Limb Flexion 52% Head deviation 37% Lateral position 11% 16% Hip Flexion 50% Hock Flexion 25% Others 25%	Frazer *et al*., 1997b
Ant. presentation Post. presentation Transverse	98.9% 1.0% 0.1%	Vandeplassche, 1987
Ant presentation	99%	Ball, 2005
Bilateral hip flexion	0.7%	Baldwin *et al*., 1991
Posterior presentation Transverse	14-16% 10-16%	Frazer *et al*., 1997b
Anterior presentation	98.9%	Christensen, 2008
Neck deviation Limb flexion	35.0% 21.0%	Frazer *et al*., 1999a
Fetal oversize Uterine inertia	1.3% 2.0%	Frazer *et al*., 1997b

vagina like melanomas, or varicose veins of vagina (common in old mares) are rarely seen (Frazer, 2007) but such mares are not usually bred. Mares with varicose veins may bleed during pregnancy or at foaling. The bleeding must be checked by standard methods or sutured under general anaesthesia (Jackson, 1995). Mares with tumors can deliver foals normally if they are not large enough. Incomplete dilation of the cervix (cervical incompetence) is sometimes seen in the mares and donkey mares (Swendsen, 1989) but the ease with which cervix of equines can be manually dilated poses little threat in dystocia management. β_2 adrenergics (Isoxsuprine HCl 200-300 mg IM or IV or clenbuterol 0.3 mg IV) (Bostedt, 1988) may be given in animals whose cervix cannot be manually dilated.

Uterine inertia is less frequent in the mare and described previously. Nervous mares may inhibit labor when disturbed (Jackson, 2004). Such mares should be left undisturbed for 20 min or a dose of 2.5-10 IU of oxytocin given IV would initiate labor within 15 min of administration (Jackson, 2004). Dropsy of fetal sacs can rarely result in uterine inertia in mare (Vandeplassche *et al*., 1976).

Hernias of the abdominal wall are more a management during pregnancy. Diaphragmatic hernia (Auer *et al*., 1985) has been reported as a maternal cause of dystocia in a mare. Rupture of the prepubic tendon is sometimes seen in heavy drought mares during the last 2 months of gestation. It must be suspected if severe painful edema is seen on the ventral surface of the abdomen (Perkina and Frazer, 1994; Mirza *et al*., 1997; Troedsson, 2007). The abdomen of such mares must be supported by canvas straps (Frazer *et al*., 1997b) and parturition initiated (Adams, 1979; Hanson and Todhunter, 1986). The prognosis is poor and mares must be assisted during delivery or a cesarean section be performed and the mare removed from further breeding (Jackson, 1995). Sometimes a mare may die shortly if the abdominal wall also ruptures (Hanson and Todhunter, 1986; Brar *et al*., 2007). Conditions like uterine torsion are discussed separately.

(b) Fetal Cause

The most common fetal causes are fetal postural abnormalities. The less frequent fetal causes include fetal oversize, fetal monsters and fetal dropsical conditions (Allen, 1986; Waelchli and Ehrensperger, 1988; Bullard and Harrison, 1995)

Fetal oversize is relatively uncommon in mares (Vandeplassche, 1992; Vandeplassche, 1993). However, breeding with males bigger than females or in some drought horses, foals with relative oversize can sometimes be born. Foals in transverse pregnancies are sometimes larger (Jackson, 1995). Prolonged gestation is generally not known to result in fetal oversize (Jackson, 1995).

Fetal monsters are rare in horses. However, hydrocephalus (Ojala and Al-Huikku, 1992; Vandeplassche, 1993; Dugdale, 2007), *Schistosoma reflexus (*Johns, 1981; Dubbin *et al*.,1990; Ball, 2005) ankylosis of one or more limbs and wry neck are known to occur (Ball, 2005). The excessive fluid must be drained from hydrocephalic and ascetic fetuses to affect delivery, and fetuses with anklylosed feet may be delivered by fetotomy. The commonly occurring fetal maldispositions are discussed separately.

3.5.3 Clinical signs of dystocia

A prolonged first stage of labour: When the first stage of labour is greater than 45-90 minutes dystocia must be suspected but should not be confused with postponement of labour by the mare due to disturbance as mares can voluntarily delay foaling.

Straining without progress:

If a mare is greater than 20 minutes in 2nd stage labour without fetal movement dystocia must be suspected (Frazer, 2009). If two fore fe*et al*one are at vulva, without progress dystocia is present. Dystocia may be accompanied by colic and forceful straining. The mare may attempt to lie down and stand repeatedly. This is characteristic of fetal disproportion, malposture or fetal maldisposition. The mare may stand quietly without any straining in cases of uterine rupture, or uterine inertia. An abnormal vaginal discharge indicates fetal death.

3.5.4 Approach to a case of dystocia

The obstetrician should reach the mare or call the mare to the hospital promptly if referral facilities are available. When managing an equine dystocia time is not on the obstetrician's side since fetal hypoxia rapidly ensues. Normal stage II of labor is explosive and short lasting, less than 20 minutes. Mare owners should be advised to keep the mare walking till the arrival of the obstetrician to reduce straining. Placing a nasogastric tube in the trachea so that glottis cannot close, or pulling out the tongue reduces the ability of mare to generate an abdominal press (Orsini and Divers, 1998). The history of the case must be obtained including behaviour, posture, nature of breathing, degree and frequency of straining, condition of allanto-chorion. Fetal extremities and conditions of vulva must be obtained. The mare must be placed in a dust free quiet area. The tail must be bandaged and secured to neck. A rapid and complete physical examination must be carried out. The perineal area must be washed before rectal/vaginal examination. A transrectal examination must be first done to be followed by vaginal examination to assess fetal position and cervical vaginal lacerations which must be brought to the notice of the owner beforehand (Threlfall, 1997). Examination is easy in standing position with epidural anaesthesia (5-8 ml of 2% lidocaine). Some authors prefer xylazine 0.17 mg/kg and carbocaine (2 to 3 ml in 8-10 ml of normal saline to reduce hind limb weakness (Frazer, 2001a). Lateral recumbency is a difficult position. The foaling mare should be approached with great care. It may sometimes show violent behavior. Repulsion of the fetus should be done carefully after ample lubrication. Lubricants such as petroleum jelly, J-lube or methylcellulose may be used (Ball, 2005). Lubricants can be pumped into the uterus with a stomach tube and pump to lubricate the birth canal. Frequent reapplication of water is necessary (Ball, 2005). Obstetric manipulations should be completed rapidly and clinicians should refer mares to referral centres when they consider that the case is difficult to handle. With live fetus the manipulations should exceed no more than 30 minutes. If the fetus is dead, manipulations ideally should not exceed an hour (Christensen, 2008). Even if the fetus is dead, a prolonged dystocia can lead to significant cervical damage and or ischemia to the caudal reproductive tract leading to scarring, adhesion formation and possibly systemic disease (Christensen, 2008). It may not be possible to achieve a meaningful yet safer repulsion of the fetus if the uterus is contracted around the fetus (Brooks *et al*., 1985; Perkins and Frazer, 1994). The obstetrician must verify that the uterus is intact, especially if there has been prior intervention by inexperienced personnel (Frazer *et al*, 1997c)

3.5.5 Sedation/Anesthesia

Examination and/or manipulation may require sedation/tranquillization of mares. Sedation must be given in nervous mares. Chemical restraint involves the use of some tranquillizers like acepromaziene.

Draught horses must be given half the dose of tranquillization suggested for other horses (Duke, 2001). For sedation, drugs like detomidine hydrochloride 10-20 µg/kg (Jackson, 1995) must be given IM or IV.
A combination of xylazine 0.15 mg/kg and acepromazine maleate 0.04 mg to 0.08 mg/kg IV (Youngquist, 1986) or xylazine 0.3-0.5 mg/kg body weight IV and butarphanol 0.1 to 002 mg/kg body weight IV is suggested (Frazer, 2001a). Various sedative combinations for standing sedation in the horse have been recently described (Duke, 2001) including alpha$_2$ adrenergic agonists like romfidine, opiods like butorphanol, tranquilizers and anesthetics. Detomidine (0.01 mg/kg) in combination with butorphanol (0.02 mg/kg) (Dugdale, 2007) or romfidine (0.05 – 0.08 mg/kg) in combination with butorphanol (0.02 mg/kg) or methadone (0.1 mg/kg) are a few of the suggested sedatives. For details the reader should refer this text (Duke, 2001). Drugs like xylazine or detomidine should not be used alone to sedate a mare with dystocia as some apparently sedated mares can become hypersensitive over the hindquarters (Frazer, 2007).
(a) Short term Anesthesia

Xylazine 1.0 mg/kg IV and ketamine 2.0 mg/kg IV induces muscular relaxation and analgesia for short period (10-15 minutes) (Youngquist, 1986). Anaesthesia can further be maintained by ketamine 2 mg/ml + xylazine (0.5 mg/ml) plus guaifenesin 50 mg/ml in 5% dextrose IV (Youngquist, 1986; Orsini and Divers, 1998).

When quaifenesin is given the cardiac and respiratory rates must be monitored and if possible 5-15 litres/minute of oxygen must be given intranasally to the mare.

A few of the recently described anaesthetic combinations describe a combination of xylazine (1.0 mg/kg), diazepam (0.02 mg/kg) and ketamine (2.0 mg/kg) or romfidine (0.1 mg/kg) and ketamine (2.0 mg/kg). For details the reader should refer the above mentioned (Duke, 2001) or other appropriate texts.
(b) Long Term Anesthesia

When procedures are to exceed 1 hour, 1 mg/ml ketamine and 0.25 mg/ml of xylazine with 50 mg/ml quaifenesin is suggested in 5% dextrose with infusion of 2 to 2.5 ml/kg per hour. Recovery ranges from 55 minutes to 3 hours.

When available inhalation gas anesthesia with *halothane* and oxygen is suggested (Embertson, 2003) after induction of anesthesia with diazepam and ketamine.
3.5.6 Methods of dystocia handling:

Classically methods of dystocia correction have been divided into *mutation forced extraction, fetotomy* and *caesarean* section (Roberts, 1986; Youngquist, 1986; Threlfall, 1997). More recently, the methods have been described as *assisted vaginal delivery*, *controlled vaginal delivery*, *fetotomy* and *caesarean* section (Embertson, 1992; Embertson, 1999; Freeman *et al*., 1999a; Frazer, 2001a; Frazer, 2001b; Embertson, 2003; Lu *et al.*, 2006; Frazer, 2007). There is no one procedure that is better than the other. The viability of the fetus, previous handling, economics of the case, clinical skills of the obstetrician and proximity to a well equipped hospital are all major considerations which a veterinarian must weigh before choosing the most appropriate course of action. When performed skillfully, a vaginal delivery using assisted or controlled delivery or fetotomy is better for some reasons compared to caesarean delivery, like; it is less stressful on the dam, it requires less recovery time and the dam is able to more easily care for the live foal. However, caesarean is considered optimum for reasons of better foal survival, less damage to birth canal and prompt delivery of a foal in danger. Certainly, as the duration of dystocia increases the morbidity and mortality rate for both the mare and foal rise (Frazer, 2001a).
(a) Assisted Vaginal Delivery:

In a normal delivery, the chorioallantois is thought to remain attached to the endometrium until after the foal is delivered. Separation of fetal membrane will deprive the fetus of oxygen and this is the critical factor that must be considered when assessing an obstetrical case that involves a live foal. Fortunately, the vast majority of dystocia can be corrected at the farm fairly quickly by brief manipulation and assisted vaginal delivery.

In assisted vaginal delivery, the mare is aware and assisted to a small or large degree for vaginal delivery of an intact foal within 10-15 minutes. If resolution takes longer than 10-15 minutes, the obstetrician should consider the alternatives for correction of the dystocia (Embertson *et al*., 1995). For assisted vaginal delivery the following points must be kept in mind:

1. Assist when the mare is lying down. If mare is foaling in standing position, the foal's umbilical cord may rupture prematurely resulting in tissue hypoxia. However, for repositioning of the foal, the mare must be standing.
2. Once the thorax of fetus is delivered traction should stop.
3. Never apply traction on a fetus with fetal maldisposition.

4. Pull fetus in a downward arc, one leg at a time to reduce the width of shoulders.

(b) Controlled Vaginal Delivery:

Controlled vaginal delivery employs general anesthesia and hoisting the mare's hindquarters upwards. The uterine relaxation and effects of gravity assist in fetal repulsion and manipulation (Frazer *et al*., 1999a; Frazer *et al*., 1999b). The position and posture of the fetus is determined, and the fetus is then repelled and repositioned to allow vaginal delivery. Manipulations must be gentle and plenty of lubrication must be used to help delivery. When the head and distal forelimbs come out in the birth canal, the mare should be lowered into lateral recumbency and traction must be applied to the foal until delivery. The umbilical cord must be clamped and cut. The mare must be placed on a thick mat for recovery. If the foal cannot be delivered within 15 minutes a fetotomy (if the foal is dead) or caesarean section (if foal is live) should be performed. Moreover, the option to perform a fetotomy may be limited if manipulations before presentation of the mare have already inflicted severe trauma (Frazer, 2001a). Congenital curvatures of the foals cervical vertebrae (wry neck) are the most common diagnosed congenital deformity (Giles *et al*., 1993; Hong *et al*., 1993) are which must be differentiate from carpal flexion or neck deviations, as a better option to deliver a fetus with wry neck is fetotomy or cesarean (Frazer, 1999) .

Fetotomy:

Many of the maldisposed fetuses can be safely resolved for vaginal delivery by fetotomy if the fetus is determined to be dead and if fetotomy is performed by skilled persons, otherwise, fetotomy is potentially hazardous for the mare (Higgins and Wright, 1999). One to two well placed fetotomy cuts can dramatically shorten the intervention time and permit atraumatic delivery of a nonviable fetus (Nimmo *et al*., 2007). The value of mare is an important factor to be considered. In one study one or two cuts were sufficient to correct 57% of the cases, and another 21% required a third cut (Frazer, 1997). The fetotomy procedure is not as easy as it is in the cow due to the longer and soft equine birth canal and the threats posed by the rapidly detaching fetal membranes (Stephenson, 2010; Frazer at al., 1997b). The fetal death can be ascertained by absence of fetal reflexes (no limb withdrawal, no ocular reflex, no swallowing reflex, no heart beat, and no anal reflex). The following points must be kept in mind while performing fetotomy in the mare (Frazer, 2001b).

Repeated in and out arm movements are contra-indicated as mucous membranes of cervix and vagina are easily abraided.

i. Cervical adhesions are almost inevitable after prolonged interventions. Obstetrical hooks are contraindicated on live fetus.
ii. For optimum future fertility fetotomy should not be preceded by prolonged attempts of manual correction.
iii. Application of copious lubricant is essential.
iv. Systemic spasmolytic agents (isoxsuprine) can be given if uterus is contracted.
v. Fetotomy can be performed in a tranquillized standing mare not essentially with epidural anaesthesia. General anaesthesia may be required in some cases.

The survival rate of mares subsequent to fetotomy was 95.8% in one study (Carluccio *et al*., 2007) and 100 percent in another (Volkmann, 2009). The complications of fetotomy include retained fetal membranes (5.5%), laminitis (6.9%), vaginal and cervical lacerations (2.8%) and delayed uterine involution (2.8%) (Carluccio *et al*., 2007). The short term and long term fertility of mares appears to be good with 80 to 83% mares conceiving subsequently (Carluccio *et al*., 2007; Nimmo *et al*., 2007).

Caesarean section in the Mare

Caesarean section in the mare is still considered a serious and dangerous operation when suitable surgical facility is unavailable. However, with good hospital facility and use of modern techniques for inducing and maintaining general anesthesia the mare survival is high (89% to 95%) (Juzwiak *et al*., 1990; Watkins *et al*., 1990; Freeman *et al*., 1999a). A poor prognosis for future fertility can be expected if the surgery is attempted after the mare has been subjected to prolonged vaginal manipulations (Farquharson and Delahanty, 1952; Farman, 1968; Coates, 1970; Cohen, 1975; Vandeplassche, 1992, 1993). The collective foaling rate after surgery has been shown to be 50% (Juzwiak *et al*., 1990), however, the reduced fertility following caesarean section has more to do with the cause and initial management of the dystocia rather than actual surgery (Vandeplassche *et al*., 1972; Juzwiak *et al*., 1990; Watkins *et al*., 1990). Acceptable foaling rates can be achieved if labor is not prolonged and the mare is < 16 yrs of age (Abernathy, 2009). The foal survival is high when the operation is performed early (38% in emergency cesarean versus 90% in elective cesarean section; Freeman *et al*., 1999a). Terminal cesarean sections carry a poor prognosis for foal survival (Hollis *et al*., 2009). If the foal is alive within the maternal pelvic canal,

it suffers from fatal anoxia because of dehiscence of the allantochorion within 1 or 2 hours of the beginning of the second stage of labor (Arthur, 1975) hence; if the foal is alive the operation should be performed with minimum delay. Due to lack of equine specialist hospitals and due to reduction in the number of equines kept globally cesarean section is limited to some places only, in the equine species.

Indications

The range of indications for cesarean in the mare is limited compared to cattle. An elective cesarean is indicated when dystocia is expected owing to partially obstructed pelvic canals, cervical adhesions or other problems, or, when saving the life of a foal is extremely important (Embertson, 1992; Watkins *et al*., 1990; Maaskant *et al*., 2010). An emergency cesarean is indicated when either all other means of dystocia correction have failed or in case of transverse pregnancy or when complete fetotomy would be life threatening to the dam. Vulvo-vaginal trauma, pelvic fractures could be other indications for an emergency cesarean section.

Anesthesia

A wide variety of anaesthetic combinations used in the past including methohexitone sodium (5mg/Kg body weight) or thiopentone sodium (10mg/Kg body weight) followed by inhalation anesthesia comprising of halothane and oxygen (Pearson, 1999) or immobilization of the mare using glycerol guiacolate followed by local infiltration anesthesia (Vandeplassche *et al*., 1977) appear to be less frequently used in current anaesthetic combinations for the mare (Johnston and Taylor, 2002). A large number of anesthetic combinations for the horse have been reviewed (Le Blanc and Norman, 1992; Mama, 2000; Frazer, 2001a; Kronen, 2003). Sufficient fluid therapy is suggested to stabilize the mare before anesthetic induction. Xylazine at the rate of 0.25-0.5 mg / Kg IV or 0.5 – 1.0 mg/Kg IM is suggested as a pre anaesthetic followed by IV infusion of guaifenesin at 5-10% via large bore needle followed by bolus administration of 1.5 to 2.0 mg/Kg ketamine for anaesthetic induction. Isoflurane or servoflurane are currently suggested instead of halothane and oxygen as they increase uterine incisional bleeding (Kronen, 2003). Morphine is suggested intraperitoneally (1mg/Kg in a constant rate infusion or a bolus over 5 to 10 min period) with a constant infusion of lidocaine (0.05mg/Kg/min) to reduce intra and post operative analgesia (Mama, 2000). Subcutaneous injection of 15-20 mL of bupivacaine at the incision line at the end of surgery is suggested to reduce post-surgical pain.

A combination of xylazine (1mg/kg, IV) followed by a combination of ketamine (2.2 mg/kg, IV) and diazepam (0.8mg/kg) for induction and isoflurane gas anaesthetic for maintenance have also been suggested (Bidwell *et al*., 2008) with triple drip anaesthetic given intravenously (50g guaifenesin, 500 mg xylazine and 1 mg ketamine) as a bolus for relaxation (Lin *et al*., 1994). Although xylazine causes some bradycardia it appears that its combination with ketamine, diazepam and guaifenesin are the drugs of choice for long term anesthesia wherever gas inhalation anesthesia is unavailable.

Operative technique

Although the operation can be performed by ventral flank laparotomy, paramedian and other approaches, currently most surgeons prefer the ventral midline approach with the mare in dorsal recumbency tilted slightly towards the surgeon (Embertson, 2003) because it considerably reduces the intra-abdominal pressure and the wound can therefore be easily repaired without excessive tension on the sutures (Pearson, 1999). All other approaches necessitate muscle division, which results in greater operative hemorrhage and post operative edema. When the midline incision is properly repaired, the risk of incisional hernia is negligible.

The mare's uterus can easily be grasped through the uterine wall and brought to the site of incision easily because the mare's uterus is seldom so tightly contracted. The incision of the uterine wall however, results in profuse hemorrhage from the sub mucosal plexus of arteries and veins. It is therefore suggested that the repair of the uterine wall must be carefully done. Haemostatic sutures placed during hysterotomy did not reduce the postoperative anemia and severe uterine hemorrhage (Freeman *et al*., 1999b). On completion of uterine closure oxytocin must be administered to assist in uterine contraction and placental expulsion (Byron *et al.*, 2003; Embertson, 2003; Maaskant *et al.*, 2010). The fetus must be carefully removed and the umbilical cord must be left intact until breathing begins in a live foal. The cord is then ligated. If the fetus is dead, the placenta may already have separated and is removed. If the placenta remains attached to the endometrium, it is better not to attempt manual separation as this may lead to profuse bleeding. The uterine incision is repaired with polyglycolic acid inversion sutures in one or two rows. An antibiotic powder is sprinkled over the uterine incision. The uterus must be placed back after washing with sufficient amounts of heparinized saline. The muscle layers and the peritoneum are closely

sutured taking care to avoid space in between. The skin is sutured using simple interrupted, mattress or interlocking sutures.

Post-operative care

The most frequent post-operative complications are abdominal pain, anemia, retained placenta (Juzwiak *et al*., 1990; Abernathy, 2009) and diffuse sub-cutaneous edema at the operative site (Pearson, 1999). Anemia is 5 times more probable following cesarean section than vaginal delivery (Freeman *et al*., 1999b). Antibiotic therapy is suggested for 3-5 days but the choice of antibiotic should be carefully done. The use of antibiotics that are excreted in bile (e.g. tetracycline) may precipitate salmonellosis in carrier animals leading to severe diarrhea that would increase the stress of an already stressed animal. Anti-inflammatory drugs and fluid therapy should be appropriately administered. When placenta was left in place during a caesarean 50 IU of oxytocin in saline is suggested if the placenta is not expelled within 4 h (Vandeplassche *et al*., 1971). Low doses of oxytocin are better as bolus injections can sometimes result into post-operative shock and hence many clinicians consider the administration of oxytocin to all mares that have undergone a cesarean section. Yet another post-operative complication that develops a few days after the operation is laminitis. The earliest signs of this anaphylactic reaction (which develops due to a retained placenta) are severe pulmonary edema, dyspnoea and nasal regurgitation of fluids. Such mares must be treated by uterine lavage, dietary restriction, anti-allergics and pain killers.

3.5.7 Commonly Occurring Dystocia and their correction

a) Uterine torsion

Uterine torsion is relatively uncommon in the mare and accompanied by signs of severe discomfort. It usually occurs in mares from 8.5 months of gestation to term. There is no known predilection and no cause can be ascertained. Less than 50% of torsions occur at parturition.(Chaney *et al*., 2007). Term uterine torsion led dystocia in 3.3% cases with uterine torsion occurring before the end of gestation in mares (Vasey, 1993). Uterine torsion has been recorded in a mare with a prolonged (515 days) gestation (Lopez and Carmona, 2010).

Clinical Signs

Torsion must be suspected when signs of colic are seen in late gestation (third trimester) (Barber, 1979). The discomfort is mild in most cases, temporarily responsive to analgesics. There is depression, pawing, flank watching, kicking, and rolling. Mares may show tachycardia, pyrexia and signs of depression (Doyle *et al*., 2002) mares developing uterine rupture may show much depression (Perkins *et al* 1992)

Physical Examination

Normal to slightly elevated temperature, pulse and respiration is found. There are normal or decreased gastrointestinal sounds.

Rectal Examination

Careful palpation of uterine walls must be done to identify uterine ruptures or tear (Perkins *et al*, 1996). Palpation reveals displacement of uterus. The uterus is felt without palpable fetus. The diagnosis is based on displacement of broad ligaments. The broad ligament on the side to which the uterus is twisted is pulled tightly under the uterus, while the one on the opposite side is stretched over the top of the uterus, leading to asymmetry of broad ligaments. In contrast to the cow, uterine torsion in the mare does not usually involve the anterior vagina or cervix. Laproscopic diagnosis of uterine tear has been suggested in the mare (Hassel and Ragle, 1994).

Non-surgical Treatment

Replacement by manual manipulation:

Manual manipulations may be attempted for correction of a recent torsion occurring at mid of gestation. This includes grasping the uterine wall per rectum and attempting to detort it.

Rolling the mare under general anesthesia:

For rolling the mare is placed on the side of torsion in lateral recumbency and rolled in the direction of twist. Placing a wooden plank (4-5 metre long x 30-50 cm wide) over the recumbent mare's upper paralumbar fossa is suggested before rolling the mare. Rolling must be done slowly (Wichtel., 1988). Rolling may be complicated by uterine rupture or abortion (Youngquist, 1986). The signs of colic disappear on correction of torsion. The detorsion must be assessed by rectal palpation. If detorsion does not occur after 1-2 gentle rolling, alternative methods must be considered. The Schaffer method of uterine torsion correction described for the cow is also sometimes used for the mare (Bowen *et al*., 1976).

Surgical treatment

A standing flank laparotomy under sedation and local infiltration anaesthesia is suggested (Maxwell, 1979; Youngquist, 1986) to correct torsion. The incision is given in the sub lumbar fossa on the side of

torsion. The uterus is repositioned by lifting the lower portion and repelling the upper portion. If fetus is dead, it should be removed by hysterotomy. Live fetuses are left undisturbed and the pregnancy is expected to continue to term. Ventral midline laparotomy under general anesthesia may be sometimes undertaken in complicated cases (Pascoe *et al*., 1981; Jung *et al*., 2008). The prognosis is fair, but worsens with uterine rupture or reverse torsion. The approach has many advantages, including rapid and clear access to the abdominal cavity, safety and visual assessment of uterine wall viability. Mid gestation torsions could be corrected successfully by this method and a high proportion of mares delivered normal foals (Jung *et al*., 2008).

Torsion at the end of gestation

The signs of colic appear in a mare and there is delay in early stages of birth, when torsion occurs in a foaling mare. Mares with torsion at foaling should never be rolled due to dangers of uterine rupture. The rotation of uterus per vaginum by holding the fetus can be attempted but is extremely difficult. The best option is performing a ventral midline laparohysterotomy. The mare survival is known to be high when uterine torsion occurred at < 320 days of gestation. The prognosis for a mare delivering a live foal is good if the mare is discharged from the hospital following uterine torsion correction with a viable foal (Chaney *et al*., 2007). The foal survival was also high (72%) when uterine torsion occurred at < 320 days of gestation (Chaney *et al*., 2007).

(b) Abnormal presentations and their correction in mares

Fetal malposture are the commonest cause of dystocia in mares (Dugdale, 2007). The commonly occurring fetal malpostures are described.

Posterior Presentation: Posterior presentation of the fetus as a cause of dystocia is exceptional in the mare (Frazer *et al*., 1999b). However, it is known to occur in 1% of all equine births (Vandeplassche, 1987; Vandeplassche, 1993; Frazer, 2001a; Dugdale, 2007). It is generally accompanied by lateral position. A foal in posterior presentation places pressure on the umbilical cord which can rapidly lead to asphyxia. Thus, if posterior presentation is detected, the foal should be delivered by traction as soon as possible (Dugdale, 2007). Occasionally hocks and hips may also be flexed in posterior presentation (Dugdale, 2007). These are difficult to correct because of the extreme length of the fetal limbs and the limited space available. The fetus is repelled and rotated to dorsal position. Rotation must be attempted by using arm and hand and after correction; the foal must be delivered quickly by assistance. Foals in posterior presentation are more likely to be in dorsoilial position than foals in anterior presentation (Frazer *et al*., 1997b).

Transverse presentation: Dystocia due to *transverse* presentation occurs in a pregnancy in which the fetus develops in both uterine horns and the uterine body. It occurs in 0.1% of births (Frazer, 2001a). The *ventro transverse* is more common. The presentation occurs more frequently (18%) in draft horses compared to lighter breeds like thorough bred and standard breed (Frazer *et al*., 1997b). As fetus grows beyond 6 months, it enters the uterine horn, instead of the uterine body. The fetus lies with its longitudinal axis oblique or perpendicular to that of the mare, with its limbs and abdominal surface presented to the pelvis. The feet or spinal column of the fetus and fetal membranes are palpable. The natural birth is impossible in such a presentation. The birth process starts with no progression and fetal membranes expulsion. Caesarean section is the best option for fetal delivery (Vandeplassche, 1980; Dugdale, 2007; Nahkashi *et al*., 2009). Fetal version or fetotomy is very difficult.

Ventrovertical (*dog sitting posture*) presentation: The incidence of such a presentation is reported to be 0.7% (Baldwin *et al*., 1991) and this is considered one of the most difficult obstetric challenge (Card, 2002). The fetal head, neck, forelimbs and hind limbs present simultaneously in the vagina. The hind limbs are impacted against the pubis or may lie alongside the fetus. Usually it is one of the hind limb that is flexed at the hip joint and this is known as ***hurdling posture*** (Baldwin *et al*., 1991; Frazer *et al*. 1997b; Dugdale, 2007). The delivery process progresses normally first and then do not progress as the thorax of fetus emerges from the vulva. The palpation of fetus is not easy due to presence of fetal head and limbs. Posterior extremities are generally wedged at the pelvic brim. If oxygen is available nasal oxygen must first be assured for the foal. Clenbuterol (300µg IV) should be given along with general anesthesia (Card, 2002). Correction of ventrovertical presentation into anterior presentation may be attempted by repelling the hind limbs by hand (grasp the fetlocks, flex the limb and repel the hind limbs deep into uterine cavity). Transverse division of the fetal trunk posterior to the last rib using a fetatome is suggested as a means of fetal delivery (Youngquist, 1986) if the fetus is dead. It is suggested that due to the lack of room for manipulation correction is usually very difficult and early election of cesarean may be the best option (Dugdale, 2007).

Abnormal position: *Dorsoilial* or *dorsopubic* are two abnormal positions that result in dystocia and commonly occur because the fetus fails to rotate into a *dorsosacral* position during delivery. The position occurs more commonly in posterior presentations (Frazer *et al*., 1999b). Since the equine fetus actively participates in attaining the correct position during stage I of labor, a dead or moribund fetus is more likely to be malpositioned (Ball, 2005). Only if the fetus is very small, it can be delivered without correction. Obstetrical rotation must be done by fixing obstetrical chains on both the fetal limbs and a mandibular snare on the head. The fetus must be freely movable for correction, and plenty of lubrication must be used. The mare may be sedated or anaesthetized prior to attempts at rotation. During strong contractions rotation is impossible and should not be attempted.

i) Lateral head deviation

Deviation of the head and neck appears to be the most common cause of severe dystocia for fetus presented cranially (anterior longitudinal) (Vandeplassche, 1987; Frazer *et al*., 1997b; Frazer *et al*., 1999a; Dadarwal *et al*., 2008 Frazer, 2009). Lateral deviation may be directly along the fetal thorax or obliquely downward (Dugdale, 2007). The feet of the fetus are seen in the vagina. The deviation must be corrected by controlled vaginal delivery. Ample lubrication must be infused and the fetus must be repelled. The lower jaw must be grasped and the deviation corrected manually. The fetus should be delivered quickly.

ii) Lateral head posture (*wry neck*)

Congenital curvature of the cervical vertebrae is known as *wry neck*. Such malpostures are difficult to correct by assisted or controlled vaginal delivery. A wry neck cannot be straightened and manipulative efforts only traumatize the genital tract (Rice, 1994). Direct amputation of the head and neck or amputation of the opposite forelimb followed by head amputation is suggested (Frazer, 1997; Frazer, 2001b). Fetotomy operations should be done under sedation and epidural anaesthesia or general anaesthesia.

iii) Deviation of the head:

Ventral deviation of the head between the forelimbs results in only the ears being palpable. In extreme cases the head is ventrally placed such that it lies adjacent to the fetal sternum (Frazer, 2001a) (breast head posture). Different degrees of ventral deviations are described by different terms (Youngquist, 1986). The posture is called *vertex* if the fetal muzzle rests against the maternal pubis. A case in which the head is displaced still further and the nape of fetal neck is presented to the pelvic inlet is described as *nape posture*. A mandibular snare is used for correction of the posture. One of the operator's hands is used to apply repelling pressure to the poll while the other hand is used to apply traction with the snare, displacing the fetal head upward and forward. Fetotomy of the displaced head is indicated if fetus is dead.

iii) Carpal flexion posture

Carpal flexion is one of the most common causes of dystocia. The limb may be presented at the maternal pelvis or ahead of the maternal pelvis (Youngquist, 1986 Nahkashi *et al*., 2008; Frazer, 2009). The fetal body must be repelled slightly, and the hoof of the foot grasped in a cupped hand is lifted while pressure is applied with the other hand over the fetlock to correct the malposture. It should be noted that the commonest congenital deformity of the knee, which is often bilateral can be present. In these cases it is very difficult to extent the limb sufficiently to allow a vaginal delivery and a cesarean section may be required (Dugdale, 2007). If the malposture cannot be corrected quickly in a live foal, caesarean section must be done, but, if the fetus is dead partial fetotomy must be done and the fetus removed by traction using obstetrics chains placed on the proximal stump (Frazer, 1997).

iv) Shoulder flexion posture

In this malposture, the limb lies alongside or under the fetal abdomen. The condition is generally unilateral (*swimmimg posture*) (Christensen,2008; Bhoi *et al*., 2010) or rarely bilateral (Christensen, 2008). The hand is introduced on the side of flexion and the radius is grasped and pulled upward towards the pelvis, converting shoulder flexion into carpal flexion which is then corrected and the fetus delivered (Dugdale,2007). Bilateral shoulder flexions (*diving posture*) are difficult to be corrected manually and fetotomy (Frazer, 1997) or cesarean section are indicated (Christensen, 2008).

v) Foot nape posture

In this malposture, one or both forelimbs are displaced upward and lie on the top of the fetal head. The posture must be corrected immediately because the foot can cause severe damage to the birth canal (Dugdale, 2007). The common sequelae are rupture of the vagina, rectovaginal fistula and third degree perineal lacerations. The fetus must be repelled, lifting the head while assistants must apply traction in a downward and lateral direction over the fetlocks until the leg is in normal position. If the fetal legs have penetrated the vaginal and rectal wall an attempt must be made to replace them in the vagina prior to correction of the malposture.

vi) Hock flexion posture

In this posture, the hind limbs are flexed, at the tarsal joint. The flexion may be unilateral or bilateral and the flexed hocks and tail of the fetus are present at vulva. Twenty five per cent of fetuses present in posterior presentation have bilateral hock flexion (Vandeplassche, 1987; Vandeplassche, 1993; Frazer *et al*., 1997b). Correction of the posture is difficult and fetotomy should be done if the fetus is dead. Manual correction can be attempted by lifting the hock upward and forward till the hoof can be extended.

vii) Hip flexion posture (Breech posture)

In this posture, both the hips of the fetus are flexed so that only tail of the fetus is seen at the vulva. Nearly half of the fetuses presented in posterior presentation have bilateral hip flexion (Vandeplassche, 1987; Vandeplassche, 1993; Frazer *et al*., 1997b; Frazer, 2001a). The condition appears to occur due to some unexplained failure of normal limb extension mechanism (Vandeplassche, 1987; Frazer *et al*., 1997b). The fetus must be repelled and converted to bilateral hock flexion which must then be corrected and the fetus delivered manually. The condition is very difficult to correct and caesarean section is indicated if the fetus is alive.

viii) Pelvic deformities

Some distortion of the pelvic canal often follows pelvic fracture. However, even quite pronounced changes do not generally impair foaling but affected mare should be watched closely at their first foaling and the possible indication for cesarean section borne in mind (Dugdale, 2007).

ix) Fetomateral disproportion

This is uncommon in equine dystocia (<2% Frazer*et al*., 1997). The size of the mare uterus plays a much greater role in limiting the size of the fetus (Allen, *et al*., 2002). Thus it is possible and safe to inseminate a pony mare with semen from a full sized stallion (Christensen, 2008). The resulting fetus will be born the size of a normal pony neonate, but then quickly catch up in growth (Allen *et al*., 2004). However, when feto-maternal disproportion occurs, it can be resolved with cesarean section or fetotomy.

x) Multiple births:

Multiple births are rare as twin fetuses usually abort or are reduced. The simultaneous presentation of two exceptionally small fetuses can be rarely seen. As twins are smaller than single foals, it is usually relatively easy to correct such malpresentations and deliver the foals without damaging the mare (Dugdale, 2007). One fetus must be repelled and the other fetus can be delivered.

(c) Complications associated with dystocia

Complications associated with dystocia have been described (Mc Gladdery, 2001; Byron *et al*., 2003; Lu et al., 2006) and include reproductive trauma, retention of placenta, delayed uterine involution, uterine infection, uterine artery rupture, uterine prolapse, lacerations of vulva, vagina or uterus, constipation and colic.

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