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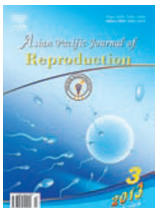

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# Perspectives of cesarean section in buffaloes

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ABSTRACT

Cesarean section in buffaloes is an emergency operative procedure being performed prinicipally for uncorrectable uterine torsions and for delivery of fetal monsters. Left paramedian (lateral and parallel to the milk vein) and oblique ventrolateral (above arcus cruralis) are the two common operative sites used for buffalo caesarean section. Although many anesthetic combinations including intravenous and inhalation anesthetic procedures have been experimented in the buffalo species yet most caesarean sections in buffaloes are satisfactorily performed in right lateral recumbency under mild sedation and local infiltration analgesia or paravertebral nerve blocks. The history, indications, anesthesia, operative procedures, post operative complications and future fertility following caesarean section in buffalo are described.

## 1. Introduction

Cesarean section is a widely used emergency operative technique for surgical delivery of buffalo calves in dystocia affected buffaloes. The fetotomy/caesarean section dilemma has been based on poor dam survival rates and poor fertility [1] however many reports depicted that dam survival is high when the operation is performed early without previous handling [2-6] and thus an early decision to perform an caesarean section greatly improves dam survival. Although the operation is an age old procedure being widely performed over many locations the technique has been poorly described in scientific literature. There has been description of newer anesthetic combinations for buffalo species that largely improve the patient safety and have little suppressive effects on the fetus their use in caesarean section in buffalo is uncommon. In this review we describe caesarean section in buffalo in view of history indications, preoperative preparation, operative sites, anesthesia, operative technique, post operative care, operative and post-operative complications and dam survival and future fertility.

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## 2. History

Although dystocia has been recorded in buffalo as early as 1928 [7], the first recorded documentation of caesarean section in buffalo appears to be that of Reddy *et al.* [8], a few other reports are also available for the 1960s [9,10]. Cesarean section in cattle had been reported as early as 18th century[11,12] however, the earliest reports of caesarean section in cows in India; the major buffalo rearing country appeared in 1930 [13] and it is possible that buffalo caesarean sections were probably performed at similar times although no reports could be traced in the literature. The technique appears to be most frequently reported since 1970s (in India) after which many case reports and clinical analyses have become available in the literature. Reports on the operation being performed at other countries of the globe are usually not traceable although they are known to be performed in many buffalo raising countries.

## 3. Indications

Difficult births in the buffalo species have been recently reviewed in terms of maternal [14] and fetal [15] causes however, the indications for caesarean section in buffalo species was not the focus of these critical reviews. A few retrospective clinical studies [16-19] documented the many reasons of dystocia for which caesarean section

had to be performed for the buffalo species. There has been documentation of a large number of maternal and fetal reasons for which caesarean sections were performed in the buffalo species (Table 1). It appears from these and a large number of retrospective clinical studies that mentioned the etiology, surgical approaches and outcome of therapy for uterine torsion in the buffalo species [3, 20–23] that the predominant reason for which caesarean section is performed in the buffalo species is uterine torsion of longer duration and uncorrectable by rolling of the dam.

Fetal monstrosities frequently pose difficulty in their vaginal delivery due to fetopelvic disproportion and thus require caesarean section for their delivery. Thus, fetal monstrosities appear to be the second most coomon reason for which caesarean section is performed in the buffalo species as evident from a large number of reports (Table 1). Fetal abnormalities like hydrocephalus, ascites and anasarca constitute the third largest reason for which caesarean section is performed for their delivery (Table 1).

Fetal maldispositions are less frequent indication for caesarean section in the buffalo. In a recent analysis [15] of 112 cases of bubaline dystocia 35.7% cases were because of fetal maldisposition however in this and previous reports[18, 24] most fetal maldispositions in the buffalo could be corrected manually and/or fetotomy and only very few required caesarean section.

The problems of cervical dilation failure appear to be extremely low in the buffalo and previous analysis depicted 4/17 [24] and 1/20 [18] caesarean sections in buffalo being performed for this reason. Cesarean sections in fetal emphysema of long standing duration are potentially life threatening and considered as a last resort [4, 25]. Similarly hydroallantois, hydroamnion and macerated fetus are poor surgical risks for perfoming the operation. Less frequent indications for caesarean section include pelvic fractures, removal of macerated and mummified fetus and extrauterine pregnancy. Elective caesarean sections are seldom if ever performed in the buffalo and caesarean is mostly an emergency operation.

**Table 1**

Maternal and fetal causes for which caesarean section was performed in buffaloes in different reports.

| | Cause of dystocia | Reference |
|---|---|---|
| Maternal | Uterine torsion | 6,8,18, 23,24 |
| | Hydroallantois/Hydroamnion | 16,24,26 |
| | Narrow pelvis/Pelvic fracture | 27,28 |
| | Insufficient cervical dilation | 18,19, 28 |
| | Extra uterine pregnancy | 29 |
| | Uterine inertia/Uterine rupture | 18 |
| | Urinary bladder carcinoma | 30 |
| Fetal | Fetal abnormalities (hydrocephalus, fetal ascites, anasarca, cleft palate). | 19,31–34 |
| | Fetal monsters | 35–39 |
| | Fetal maldisposition | 18,24,40 |
| | Fetal oversize/ emphysema | 4, 18,25 |
| | Mummified fetus | 16 |
| | Macerated fetus | 41, 42 |

## 4. Preoperative preparation

Preoperative preparation includes assessment of hematologic and blood chemistry values and administration of sufficient fluid replacements, antibiotics and corticosteroids as per the requirement [43]. Respiratory alkalosis has been documented in buffaloes with dystocia and uterine torsion [44, 45] that underwent caesarean section[46]. Buffaloes with uterine torsion showed normocytic normochromic anaemia and leucocytosis accompanied by neutrophilia and monocytosis[47, 48]. Biochemical analysis revealed significant ($P$<0.01) changes in the plasma levels of AST, LDH, glucose, total protein, albumin, blood urea nitrogen (BUN) and creatinine in the affected buffaloes than the control [48]. Following uterine torsion and after its correction by detorsion or surgical treatment, the liver functions are affected [48–51], which usually gets stabilized within 10 days after surgical treatment of uterine torsion. At the time of presentation of a uterine torsion case, a substantial increase in plasma urea and creatinine indicates poor prognosis [48]. In uterine torsion, ureters lying in the broad uterine ligaments are constricted thus the urine output is decreased and renal functions may get affected [52]. It is thus important to monitor the buffaloes for their general condition and institute therapy as per the requirement.

Buffaloes are susceptible to complications associated with recumbency of anesthesia including tympany, regurgitation and aspiration pneumonia. Accordingly it is suggested that buffaloes should be fasted for 12–18 h and deprived of water for 8–12 h however, since most caesarean sections in buffaloes are performed on an emergency basis this is not usually possible. Glycopyrrolate (0.005–0.01 mg/kg IM or 0.002–0.005 mg/kg IV) have been suggested for cattle to prevent salivation during anesthesia [53]. Studies on buffalo calves that were administered 0.01 mg/kg IM of glycopyrrolate revealed reduction in oral secretions with dry muzzle, mouth and nostrils within (41.50±3.34) min of administration and significant increase in pulse pressure but without significant variation in heart rate and mean arterial pressure [54] and thus its use was suggested for the buffalo to reduce the oronasal secretions.

## 5. Restraint

Restraint of animals depends upon the operative site

used. In most caesarean sections performed on the left side, buffaloes are restrained in right lateral recumbency with both fore legs and both hind legs tied separately (with 2 ropes) in the ventrolateral approaches and the surgeon can sit on small stools to perform the operation. For paramedian approaches the animal is slightly tilted and the left hind leg is pulled more caudally to expose the operative site for the approach of the surgeon.

## 6. Operative sites

Not all approaches mentioned for caesarean section in cattle [55] have been used in buffalo probably because caesarean section is mostly performed in a recumbent buffalo due to a heavy capacious abdomen. The principal operative site reported in most clinical studies is the left paramedian approach lateral and parallel to the milk vein (Table 2). In Iran similar site is commonly used for caesarean section in buffaloes (Azawi OI personal communication). A major flaw with most reports on caesarean section in buffaloes is the absence or poor description of the anesthesia and operative procedures used preventing clear analysis of the operative sites in different studies.

Left oblique ventrolateral site (above the arcus cruralis) is the second commonly used operative site for caesarean section in buffalo (Table 2) and considered by a few surgeons as a better operative site [6, 18, 24, 56] due to lesser post operative complications and minimum contamination of the operative site during sternal recumbency. Flank laparotomies are not commonly used for caesarean section in the buffalo.

Only one retrospective clinical study on buffalo caesarean sections compared the complications of caesarean sections performed employing different operative sites, and suggested that the midline and paramedian operative sites resulted in more post operative complications like wound dehiscence and hernia due to the heavy weight of abdomen resting on the suture line [24] and this was the only report which depicted the use of midline site for caesarean section in the buffalo. This approach is seldom used in buffalo due to difficulty in patient positioning during surgery.

**Table 2**
Operative sites and anesthesia used in caesarean section in buffaloes in different studies.

| Operative site | Anesthesia | Reference |
|---|---|---|
| Left paralumbar fossa | Paravertebral nerve block and sedation with chlorpromazine | 57 |
| | Paravertebral nerve block and sedation with triflupromazine | 58 |
| | Local infiltration analgesia and sedation with triflupromazine | 59 |
| | Local infiltration analgesia | 26,60 |
| | Paravertebral nerve block | 43 |
| Lower Left flank | Not mentioned | 3, 21 |
| Right flank | Paravertebral nerve block | 27,61 |
| Left Paramedian (Lateral and parallel to milk vein) | Local infiltration analgesia with 2% lidocaine | 1,3,36 |
| | Local infiltration analgesia and sedation with triflupromazine | 2,24,33,39 |
| Right Paramedian | Not mentioned | 19,35 |
| | Local infiltration analgesia and sedation with triflupromazine | 61 |
| Left Oblique Ventro–lateral (Above arcus cruralis) | Local infiltration analgesia and sedation with triflupromazine or xylazine | 6, 18,24,56 |
| Midline | Local infiltration and sedation with chlorpromazine | 24 |
| Sacrosciatic | Local infiltration analgesia and sedation with triflupromazine | 41 |

## 7. Anesthesia in buffaloes

Most caesarean sections in buffaloes are an emergency and can be satisfactorily performed under local infiltration analgesia using 2% lidocaine. Vicious buffaloes may require some sedation using triflupromazine, chlorpromazine or xylazine. The anesthetic management of cattle has been mentioned in detail including drugs used for sedation, induction and maintenance of anesthesia [62]. Descriptions on large number of sedatives, induction agents and general inhalation anesthetics have appeared during the last few years for the buffalo species and are thus mentioned here for reference.

### *7.1. Chloral hydras*

An anesthetic mixture used in early studies comprised of chloral hydrate (30 g), magnesium sulphate (15 g) and thiopental (2.5 g) in 1 000 mL of distilled water [63] or administered IV at 2.0 mL/kg. This was administered 30 min after SC administration of atropine. In another previous report chloral hydrate alone at 102 mg/kg IV or combined with thiopental sodium (1 g/200 kg) was administered to buffalo calves [64]. Earlier reports also depicted oral administration of chloral hydras in jaggery [58]. These combinations produced marked cardiopulmonary effects and hence are no more used in most bubaline caesarean sections. Chloral hydrate alone is known to result in a significant tachycardia, moderate transient hypotension and a significant fall in central venous pressure with significant alterations in acid base balances [64] and hence its use is not currently suggested.

### 7.2. Xylazine

Xylazine is known to cause marked sedation in the buffalo species with increased salivation, regurgitation and bradycardia at dose rates of 0.22 and 0.44 mg/kg administered IV or 0.44 mg/kg administered IM [65-67]. Recovery times with xylazine are prolonged (150 min) with an IM administration. The administration of 0.04 mg/kg of atropine IM before xylazine administration reduces salivary secretions and bradycardia [65, 66] however; lower IM dosage of 0.10 to 0.15 mg/kg of xylazine have been suggested in one study on buffalo calves [68] and dosage as low as 0.04 mg/kg in combination with 0.04 mg/kg atropine sulphate have been suggested to be satisfactory in a recent study [69]. The sedative effects of xylazine can be reversed within 15 min by IV administration of yohimbine (0.125 mg/kg) or atipamezole (10 μg/kg) [70]. Xylazine may increase the uterine tone, increase secretions, increase the risk of aspiration pneumonia and lead to ataxia so it must be used carefully in the buffalo [71].

### 7.3. Triflupromazine

Both triflupromazine and chlorpromazine have been used for sedation of buffaloes for caesarean section [23, 33, 39, 57, 59]. Triflupromazine administered at the dose rate of 5 mg/100 lb to buffalo calves produced sedation within 10-30 min of an IM injection and the effect lasted 70-180 min with minimal cardiac and respiratory suppression [72]. Combination of triflupromazine (0.3 mg/kg IM) followed 10 min later by IV administration of romfidine (10 μg/kg) and ketamine (5 mg/kg IV) produced satisfactory anesthesia in buffalo claves for (14.0±2.3) min whereas romfidine alone (10 μg/kg) resulted in rapid onset and sedation for (31.0±4.8) min [73].

### 7.4. Ketamine

Ketamine (2.0 mg/kg IV) has been combined with chlorpromazine (2.0 mg/kg IM) to anesthetize water buffalo claves. Pre treatment with chlorpromazine increases the duration of analgesia and recovery time beyond that achieved with ketamine alone. However, such combinations are suited to short term surgical procedures of 5 to 10 min [74] and thus not suitable alone for caesarean section in buffalo.

### 7.5. Detomidine and medetomidine

Detomidine (40μg/kg) administered IM produces marked ataxia and sternal recumbency in buffalo calves (85-140 kg weight) within 10 min of injection and complete recovery occurs in 90 min. However, marked bradycardia is observed for the first 60 min of injection [75]. Administration of medetomidine (10 μg/kg IV) and romfidine (50μg/kg) produced moderate sedation, mild muscle relaxation and mild analgesia in buffalo calves with romfidine resulting in marked cardiopulmonary depression compared to medetomidine [76] and the drugs were considered safe for clinical examination only. In recent years these drugs have been used in varying amounts as sedatives or induction agents during anesthesia in buffaloes.

### 7.6. Propofol

The IV administration of propofol (4.0 mg/kg) resulted in sternal recumbency in buffalo calves within (25±3) s, however this dose produced only cutaneous analgesia with complete recovery in (39±3) min [77]. Propofol at dosage of 3.0 mg/kg has been recently suggested as a safe and rapid agent for induction of anesthesia that produced satisfactory conditions for endotracheal intubation for inhalation anesthesia [78].

### 7.7. Guaifenesin

Guaifenesin has been considered as muscle relaxant in buffalo claves [79] however, the use of guaifenesin (165 mg/kg IV) alone in water buffalo calves to produce complete immobilization causes significant hypotension. Cardiovascular and respiratory despressant effects produced by high doses of guaifenesin are generally undesirable [80].

### 7.8. Short term anesthesia

Various combinations for short term intravenous anesthesia have been experimented in the buffalo. Xylazine has been suggested as a sedative and general anesthetic in buffalo [81] or as a premedication with thiopentone sodium [82]. In one study adult male buffaloes were administered medetomidine (2.5 μg/kg) and butorphanol (0.05 mg/kg) intravenously as preanesthetics. Anesthesia was induced with 5% thiopental and maintained by continuous IV infusion of either ketamine (1%) or propofol (1%). Anesthesia could be successfully maintained for up to 2 h with propofol producing some cardiopulmonary depression [83]. Other combinations suggested include combinations of triflupromazine-romfidine and ketamine [73], medetomidine and ketamine [84], or detomidine, diazepam and ketamine [85].

### 7.9. Inhalation anesthesia

Earliest mention on the use of inhalation anesthesia in buffalo calves using chloroform with oxygen and nitrous oxide following induction with intraval sodium (22 mg/kg IV) and premedication with triflupromazine (15 mg/100 kg IM) was reported in 1972 [86] however, due to serious hepatotoxicity with chloroform its further use was uncommon. Reports on the satisfactory use of long lasting inhalation anesthesia in water buffaloes have appeared in the literature [83, 87-90] however their use is dictated by the availability of proper facilities and delivery equipment which are currently unavailable at most bubaline obstetric clinics. Moreover, the cost of anaesthetics limits their use for water buffaloes. Endotracheal intubation in the larynx is required to provide a safe airway and prevent aspiration of salivary and ruminal contents if passive regurgitation occurs [62]. One study on the use of inhalation anesthesia evaluated fentanyl

(5 μg/kg IV) and medetomidine (2.5 g IV) as preanesthetic and 5% thiopental as induction agent with anesthesia being maintained with 2% halothane or 2% isoflurane [89]. None of the drug combinations produced deleterious effects on the vital organ functions, and cardio-pulmonary functions were well preserved. The same authors also evaluated and found that fentanyl-dexmedetomidine-thioental-isoflurane and fentanyl-medetomidine-thiopental-isoflurane produced effective surgical anesthesia in water buffaloes and were safe, as cardiopulmonary functions were well preserved with these combinations [90]. In another study medetomidine (2.5 mg/kg IV) and butorphanol (0.05 mg/kg IV) used as premedication and anesthesia induced by 5% thiopental sodium and maintained with halothane produced better sedation, analgesia and muscular relaxation (safely maintaining anesthesia for 2 h) compared to when buffaloes were premedicated with midzolam (2.5 mg/kg IV) and butorphanol (0.05 mg/kg IV) [88].

### *7.10. Spinal anesthesia*

The use of spinal anesthesia has been documented in some reports on caesarean section in buffaloes. The most common spinal anesthesia used is paravertebral nerve block and to a limited extent epidural anesthesia.

#### *7.10.1. Paravertebral nerve block*

The earliest available report on the use of paravertebral nerve block in buffaloes appeared in early 1970 [57, 58, 91]. The anesthesia involves regional deposition of local anesthetic around spinal nerves (13th thoracic, 1st and 2nd lumbar nerves) and its use has also been documented in later reports on caesarean section in buffaloes (Table 2). The dosage of local anesthetic deposited at these sites varies from 10 mL[58] to 20 mL [91] of 2-4% novocaine or lidocaine. In a recent study the doses have been claimed to be reduced to 5 mL of 2% local anesthetic when the anesthesia was deposited safely under ultrasound guidance [92].

#### *7.10.2. Epidural anesthesia*

The earliest documentation of epidural anesthesia using 2% lidocaine appears to be that of Lyatifov [93] and the local anesthetic is suggested to be deposited in the intercoccygeal space between last sacral and 1st and 2nd coccygeal vertebra which produces anesthesia of hind quarters and is evident by loss of senses in the tail which becomes flaccid within 2-3 min of administration. A variety of local anesthetics and sedatives have been tested in buffaloes to achieve safe spinal analgesia [94-98] however, since these approaches are seldom used for caesarean section in the buffalo [99] their detailed description is not mentioned and readers should refer appropriate texts.

## 8. Operative procedure

The usual operative procedures utilized for surgical interventions should be followed. The detailed description on the surgical technique has been recently mentioned[43]. Briefly, the operative site is prepared by shaving and scrubbing and local infiltration anesthesia is infused at the operative site using 60-80 mL of 2% lidocaine or xylocaine. The skin is incised and separated from the subcutaneous layer. The muscles are then incised ligating all the bleeding vessels. The assistant should hold the muscle layers with tissue holding forceps and the surgeon should cut the muscles taking care to avoid major vessels. After separation of the muscles by blunt dissection the peritoneum which is a glistening white layer is cut by first making a nick with a scissor and then guiding the cut by a finger placed underneath the peritoneum. The attachments of the muscles below the peritoneum are cut when using the ventrolateral approach. The omental fat sometimes covers the uterus which is pushed to the side or sometimes incised. The uterus is located and brought to the operative site by holding the uterus over a fetal leg. The uterus is packed on the sides by surgical drapes. The uterus should be incised away from the cervix over the greater curvature avoiding the cotyledons. In long standing cases of dystocia or uterine torsion sometimes it is not possible to bring the uterus at the operative site and under such conditions the uterus has to be incised in the abdominal cavity. The fetus is removed as quickly as possible and the margins of the uterus are washed with sterile normal saline. Removal of parts of the necrosed/ischemic uterus is suggested [60] for the rest of uterus to regain normal function. The placenta should be removed if it is easily separable otherwise it should be left in place.

The uterus is sutured using absorbable suture material (Chromic catgut or polygalactin 2/0 or 3/0) employing lambert , cushing [1] or uterecht inversion suture pattern as described for cattle [55]. If uterine ruptures are detected it is desirable to inject 20-40 IU of oxytocin in the uterine wall to reduce the uterine size. After completion of uterine sutures it is proper to change the gloves to minimize abdominal contamination. The uterus is replaced back in the abdomen after thorough washing. Shreds of tissue debris and contaminants that can inadvertently enter the peritoneum should be removed by infusing the peritoneal cavity with normal saline and scooping out the contents manually or by using suction apparatus. Placement of antibiotic pessaries inside the uterus before its final closure has been suggested [1]. The muscle and peritoneal layers are sutured using the same suture material and employing continuous suture pattern. Sometimes, interrupted sutures may be used. It is often beneficial to sprinkle antibiotic powder between the suture layers especially while removing an emphysematous fetus. The skin is sutured employing simple or mattress interlocking interrupted sutures using silk. Needle holders and curved needles should be sufficiently strong for suture of buffalo skin which is very thick. A sterile drape is applied over the suture line and this should be protected by applying a cloth over the abdomen.

## 9. Post-operative care

The success of the operation depends upon the post-operative care. Sufficient fluid replacements, antibiotics and anti-inflammatory drugs should be given for 3-5

days to combat toxemia. The use, type and frequency of administration of antibiotics depend upon the condition of the patient and the presence of endotoxemia. Sterile procaine penicillin G 22 000U/kg IM every 24 h for 5-7 days or oxytetracycline 10-20 mg/kg IM daily for 3-7 days is satisfactory. Combinations of ampicillin and cloxacillin 5-10 mg/kg IM or IV every 12 h for 5-7 days have yielded satisfactory results in most caesarean sections in buffaloes and this combination is combined with an IV infusion of metronidazole (10 mg/kg) in the presence of an emphysematous fetus or when peritonitis due to contamination of the abdominal cavity during surgery is suspected. Based on disposition kinetics and uterine tissue concentrations the dose of neomycin suggested for dystocia affected buffaloes is 3-5 mg/kg IV followed by 2 mg/kg IV [100]. Meloxicam (0.25 mg/kg IM) or combination of phenylbutazone (10 mg/kg) and sodium salicylate (1 mg/kg) are suggested to be administered IM daily for 5 days to minimize inflammation and thus prevent adhesion formation. Methylergometrine maleate (5-10 mg IM) is suggested if post operative uterine bleeding is noticed. The operative site should be cleaned daily with spirit. Antihistaminics should be given along with other drugs as required. The sutures can be removed 8-10 days post-operative.

## 10. Post operative complications

Both operative and post-operative complications have been less frequently mentioned for the buffalo. Cesarean section is frequently opted in the buffalo as an emergency operation of the last resort and under such situations negative outcome is more likely. The most common operative complication appears to be abdominal contamination which seems unavoidable in cases presented after sufficient delay. Buffaloes with previous handling may have developed adhesions that prevent bringing of the uterus to the operative site and thus its incision inside the abdominal wall. In extreme cases the uterine wall is so thin that it tears on handling and difficult to suture subsequent to calf removal. Accidental excision of the placentomes may result in profuse sometimes fatal bleeding. Other less frequent operative complications like gastrointestinal trauma described for cattle [55] were not observed in any of the 65 cesarean sections performed at our referral center probably because we exclusively used the left oblique ventrolateral approach for the operation with minimal handling of the gastrointestinal tract. Postoperative complications of caesarean section described for cattle [55, 101] include peritonitis, seroma formation, metritis, skin suture dehiscence, subcutaneous emphysema, adhesions, poor subsequent fertility and low milk production. Peritonitis is the most frequent post operative complication that follows bubaline caesarean section. In 65 caesarean sections performed at our referral center 28 buffaloes developed severe peritonitis that proved fatal in 18 buffaloes. Clinical signs of peritonitis in buffaloes usually appear within 72 h of the operation [43]. Higher rates of development of peritonitis appear to be because buffaloes were presented after sufficient delay with previous handling. Most buffaloes with emphysematous fetus had peritonitis as a post operative complication (Table 3). Peritonitis may be caused by compromise of the uterine wall even before surgery [39] and may be the result of exogenous or endogenous bacterial flora [102]. Delayed cases of dystocia in buffaloes evidence elevated blood histamine and serum creatine kinase along with severe uterine damage [103] thus favouring development of peritonitis on surgery.

Fluid accumulation at the operative site is common in buffalo caesarean sections but usually disappears in 5-7 days. Suture dehiscence was noticed in 5 buffaloes out of the total 65 buffaloes operated (Table 3). The poor uterine involution in caesarean operated buffaloes is related to the condition of the uterus at the time of operation. Buffaloes with a healthy uterus at operation generally do not evidence poor uterine involution.

**Table 3**
The cause of dystocia for which caesarean section was performed, dam survival and post operative complication in 65 cesarean sections performed at referral centre Bikaner (2000-2012).

| Cause of dystocia | Number of buffaloes | Post operative complication | Dam survival (%) |
|---|---|---|---|
| Uterine torsion | 46 | Peritonitis 20<br>Suture dehiscence 3 | 73.9 |
| Emphysematous fetus | 8 | Peritonitis 6<br>Suture dehiscence 2 | 37.5 |
| Narrow pelvis | 4 | – | 100.0 |
| Fetal maldispositions | 5 | Peritonitis 2 | 80.0 |
| Incomplete cervical dilation | 2 | – | 100.0 |
| Total | 65 | Peritonitis 28<br>Suture dehiscence 5 | 72.3 |

Uterine adhesion formation has been the matter of serious concern among clinicians and farmers, although little information is available on the extent of adhesion formation in caesarean operated buffaloes. A few studies compared the different approaches to prevent adhesion formation in caesarean operated buffaloes [5, 104-106]. The intraperitoneal infusion of 1% sodium carboxy methyl cellulose decreased inflammation and adhesion formation in caesarean operated buffaloes [104, 105]. Similarly use of polygycolic acid as suture material decreased inflammatory reaction in uterine tissue compared to chromic catgut [105-107] preventing adhesion formation.

The effect of a caesarean section on milk production is difficult to evaluate because of numerous confounding variables, however in general milk production is considered to be decreased.

## 11. Survival rates and future fertility

The dam survival rate of 36 to 100 per cent has been recorded following cesarean section in dystocia affected buffaloes [6, 24, 28, 56, 107]. The time elapse since dystocia onset and the performance of the operation is an important determinant of the outcome. Dam survival rates are high (64.7% to 100.0%) when the operation is performed within 24-36 h of dystocia onset [2-6] whereas survivability may decrease to 25%-33.0% when the operation was performed after 72 h [3, 4, 19]. The total dam survival rates for 73 cesarean sections performed by

practitioners in the field was 67.1% whereas for 102 cesarean sections performed at the referral centers dam survival was only 43.2% probably because of prompt performance of the operation by the practitioners compared to delay in presentation to the referral centers[4]. Dam survival is known to be poor for caesarean sections performed in buffaloes with emphysematous fetus as observed in our evaluation and previous studies [28, 107].

Previous handling is an important factor that determines the outcome of surgery. In a few clinical analyses the survival of caesarean operated buffaloes was high (62%–100%) for buffaloes with uterine torsion when the operation was performed without previous rolling [2, 19, 21] but decreased to 45%–66% when uterine torsion affected buffaloes were operated after previous rolling. Little information is available on fetal survival in caesarean operated buffaloes. Since most caesarean sections are performed as an emergency operative procedure with frequently being performed for uterine torsion and fetal monstrosities, the fetal survival is expected to be low as the fetus is either abnormal or dies dues to hypoxia. For 59 cesarean sections performed at one referral center in uterine torsion affected buffaloes only 2 live calves could be delivered [56]. Similarly in another report only 6.1% live calves could be delivered for 29 cesarean sections performed on uterine torsion affected buffaloes [6]. None of the monsters reported to be delivered by caesarean section in buffaloes (Table 1) was mentioned to be delivered alive. Thus dam and fetal survival can be improved if the operation is performed early before setting up of toxaemia and fetal death.

The future fertility of caesarean operated buffaloes has been and continues to be a matter of concern for clinicians and farmers alike; however, very few reports have addressed this issue. Singh and Dhaliwal [4] observed that 27.7% of caesarean operated buffaloes conceived subsequently whereas Purohit and Mehta [18] found that 37.5% of caesarean operated buffaloes conceived subsequently whereas information on 12.5% of buffaloes could not be traced due to sale of buffaloes and nearly similar conception rates were also observed in a recent study [1].

## Declare of interest statement

We declare that we have no conflict of interest.

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