Endometritis is the inflammation of the endometrial lining of uterus without systemic signs, extending no deeper than the stratum spongiosum. It is associated with chronic postpartum infection of the uterus with pathogenic bacteria, primarily A. pyogenes (Bondurant, 1999). Histologically, it is characterized by some disruption of surface epithelium, Infiltration with inflammatory cells, vascular congestion and stromal edema and varying degrees of lymphocytes and plasma cell accumulation (Debois and Manspeaker, 1986). Endometritis constitutes 46% of reproductive disorders in bovines and remain as a prominent cause of repeat breeding (Arthur et al., 1989). Endometritis is a risk factor for cystic ovarian disease, anoestrus and other reproductive disorders (Grohn, 1990). Along with retained placenta, puerperal metritis, pyometra and other non-specific infections of the uterus, it is one of the significant causes of declining fertility in cattle (Noake and Parkinson, 2001).

Prevalence

Spain the prevalence of endometritis in cows varied from 2.6 to 4.5%, in Denmark, 6.25%, in Korea 47.6%, while in Australia, it varied from 5.6 to 10.9%, in USA 10.3% and in UK 10.1%. Prevalence rate of endometritis 53% among dairy herds in delays uterine involution and perturbs fertility in USA using cytological methods for the diagnosis of uterine bacterial infection, bacterial products or uterine diseases.

Prevalence rate of endometritis in India ranges from 3 to 25% (Pandit, 2004; Das et al., 2004) in cows. Prevalence rate of endometritis in different regions of Gujarat in which 10.38% in buffaloes and 8.90% in cows in AMUL Dairy area.
Stillbirth, Multiple births and Metabolic disorders like milk fever, ketosis (Markusfeld, 1987) are also serve as a risk factor for endometritis. The effect of post partum endometritis on reproductive performance in dairy cows in which interval from calving to first service, calving to conception and number of first service per conception were longer in the endometritis group than non endometritis group of animals. Whereas first service conception percentage is lower in endometritis group of animal than non endometritis group of animal (Kaneene et al., 1995).

Classification of Endometritis

Acute Endometritis is usually found after 21 days postpartum with a large amount of uterine exudates containing a foul smelling red/brown watery fluid with thin uterine wall. Chronic Endometritis is observed in animals from 21 days after parturition with an abnormal mucopurulent or purulent vaginal discharge or clear mucus with flakes of pus or cloudy mucus or mucopurulent discharge and Uterus and cervix not fully involuted. The animal may be cyclic or non-cyclic and Sub clinical endometritis is characterized by inflammation of the endometrium that results in a significant reduction in reproductive performance in the absence of signs of clinical endometritis. In which > 18% netrophils in uterine cytology samples collected 21-33 days post partum or > 10% neutrophils at 34-47 days (Sheldon et al., 2006). Mild Endometritis in cows with predominately clear mucus with some flecks of pus on vaginoscopy. Mucopurulent Endometritis in cows with mucopurulent discharge on vaginoscopy, Purulent endometritis; cows with purulent discharge on vaginoscopy, Endometritis with fluid in uterus: cows with purulent or mucopurulent discharge on vaginoscopy and appreciable amount of fluid in uterus detected by transeccral palpation (Miller et al., 1980).

Clinical Endometritis and its grading method

As the presence of a purulent uterine discharge detectable in the vagina 21 days or more post partum, or mucopurulent discharge detectable in the vagina after 26 days post partum. Grading method of clinical Endometritis is based on vaginal mucus character which is graded as: 0 = clear or translucent mucus, 1 = mucus containing flecks of white or off-white pus, 2 = exudates containing < 50% white or off-white mucopurulent material, 3=exudes containing >50% purulent material, usually white or yellow (Sheldon et al., 2006).

Based on number of colony forming units (CFU): Endometritis grades reflect the number of pathogenic but not opportunist non-pathogenic bacteria isolated from the uterus of cattle data are presented as semi quantitative scores of the number of colony forming units (CFU) from uterine swabs, where CFU score; 0 = no growth; 1 = < 10 CFU; 2 = 10 to 100 CFU; 3 = 101 to 500 CFU; 4 = > 500 CFU (Williams et al., 2005).

Biochemical parameters

The pH (7.88±0.01 vs 7.18±0.08), alkaline phosphatase (373.20±66.90 vs 236.33±15.00) and total protein (0.679±0.06 vs 0.395±0.03) in the uterine flushing were higher in cows with endometritis vs healthy, respectively. These finding can be used to predict subclinical endometritis (Ravikumar et al., 2007).

Uterine defense mechanism

Bacterial infection with E. coli and A. pyogenes are common after parturition. (Sheldon et al., 2002) The innate immune system is alerted by endometrial cell TLRs detecting pathogen-associated molecules (such as bacterial DNA and lipids) and E. coli LPS, which is bound to LPS-binding protein (LBP). The bovine endometrial cells secrete cytokines and chemokines to direct the immune response, increase the expression of AMPs and secrete principally PGE rather than PGF. Bacterial infection causes endometrial damage and inflammation, reducing the chance of conception.

Cytokines and chemokines directly the immune response. Chemokines attract neutrophils (PMNs) and macrophages (MOs) to eliminate the bacteria. However, neutrophil function is often compromised in cattle around the time of parturition. Persistence of PMNs in the endometrium in the absence of bacteria is thought to be the primary characteristic of subclinical endometritis (Gilbert et al., 2005).

It is thought that viral replication may be stimulated in macrophages that are persistently infected with BoHV-4 by PGE and LPS. The BoHV-4 can then infect the endometrial stromal and epithelial cells, causing further tissue damage. The follicle stimulating hormone (FSH) concentrations from the pituitary are unaffected by uterine disease and so waves of ovarian follicles emerge in the first weeks after parturition (Sheldon et al., 2002). However, the release of GnRH from the hypothalamus and LH from the pituitary can be suppressed by LPS, reducing the ability to ovulate a dominant follicle.

Cows with endometritis have slower growth of dominant follicles in the ovary and lower peripheral plasma estradiol concentrations and so are less likely to ovulate. Follicular fluid contains LPS in animals with endometritis, granulosa cells express the TLR4/CD14/LY96 (MD2) complex required to detect LPS and LPS perturbs estradiol secretion from granulosa cells by reducing aromatase expression.

If cows with endometritis ovulate, they form corpus luteum secreting progesterone and reinitiate ovarian cycles. However, the peripheral plasma concentrations of progesterone are lower than those in normal fertile animals. Cytokines may perturb luteal cell steroidogenesis Luteolysis is probably disrupted and luteal phases are often extended because bacteria switch the endometrial epithelial secretion of prostaeglandins from the F series to the E series (Herath et al., 2007).

Uterine infection and ovarian function

Uterine bacterial contamination alters the location of ovarian follicle emergence, selection and inhibits follicle growth and function. There was no effect of bacterial contamination on plasma FSH concentration profile or emergence of the ovarian follicle wave (Sheldon et al., 2002). First postpartum dominant follicle grows slower and produces less oestradiol.
in animals with high numbers of bacteria contaminating the uterine lumen (Williams et al., 2007). Cows with postpartum uterine infection has slower growth of the first postpartum dominant follicle and lower peripheral plasma estradiol concentrations around the time of maximal follicle diameter and if ovulate, peripheral plasma progesterone concentrations were lower 5-7 days after ovulation (2 vs. 5 ng/ml). These effects of uterine microbes on ovarian function could be caused by PAMPs or inflammatory mediators acting on the hypothalamus, pituitary, or ovary. FSH concentrations are not affected in animals with uterine disease. Lipo polysaccharides (LPS) suppresses hypothalamic release of GnRH from pituitary secretion of LH and the sensitivity of the pituitary to GnRH. The consequences of these changes would be that animals are less likely to ovulate. Normal animals has not measurable concentrations of LPS in their ovarian follicular fluid while animals with clinical disease had concentration of LPS that ranged up to 0.8 µg/ml and animals with subclinical disease had intermediate concentration about 40 to 60 days after calving. Theca cells convert cholesterol to androstenedione, which then passes across the basement membrane of the ovarian follicle and is converted to estradiol by the granulose cells. As with endometrial cells, LPS does not affect theca cell or granulosa cell survival. The effect of LPS on bovine granulosa cells appears to be a direct one, as the granulosa cell cultures were free of contaminating leukocytes. Furthermore, granulosa cells from cattle express the TLR4/CD14/LY96 (MD2) complex required for binding LPS. Granulosa cells have a mechanism for direct action of LPS in the ovarian follicle to impair ovarian function and ovulation. The effect of uterine disease on follicular function may be further enhanced by cytokines released by the endometrial cells cause granulosa cell steroidogenesis is also impaired by proinflammatory cytokine If animals ovulate, the cytokines secreted by the infected endometrium may also partly explain the reduced progesterone secretion from the corpus luteum because bovine luteal cells are highly responsive to a range of cytokines and cytokines are also important in luteolysis (Sheldon et al., 2009).

Diagnosis

Classical diagnosis of endometritis on the basis of clinical manifestation and rectal examination is common. (Roberts, 1986). Biopsies and culture of uterus have been used as means for the diagnosis but these methods are impractical and of limited use in the field (Arthur et al., 1989). New diagnostic device (Metricheck) and ultrasonography are adequate to diagnose endometritis accurately (McDougall et al., 2007). Most common diagnostic technique for endometritis in clinical practice is rectal palpation, whereas vaginoscopy is an uncommonly employed diagnostic tool (Youngquist and Shore, 1997).

Techniques used for diagnosis of Endometritis are

Rectal palpation

Uterus is asymmetrical uterine horn, Thickened uterine walls, Palpable presence of fluid, cervical diameter of more than 7.5 cm (Miller et al., 1980).

Vaginal examination

Vaginoscopy along with rectal examination has been found to be more accurate method (Miller et al., 1980).

Histopathological examination

Histologically, it is characterized by, some disruption of surface epithelium, infiltration with inflammatory cells, vascular congestion and stromal edema and varying degrees of lymphocytes and plasma cell accumulation (Debois and Manspeaker, 1986).

Bacteriological examination

Presence of A.pyogenes and gram-negative anaerobes is demonstrated to be positively related with severity of inflammatory changes in endometrium. The cervix is grasped per-rectum and introduce catheter into cervix and then uterine body. The inner rod of the catheter was pushed forward to expose the swab to the endometrium and was rotated against the uterine wall and then withdrawn within the catheter. Swabs were cultured immediately on sheep blood agar and MacConkey agar and incubated at 37°C for 48 h. The same culture on sheep blood agar was incubated anaerobically for up to 7 days. Standard biochemical tests were used for the isolation and identification (Miller et al., 1980).

Whiteside test

It is an effective tool to diagnosis sub clinical endometritis which cervical mucus is collected from repeat breeding cows and add equal quantity of NaOH and boiled then observe change in colors. Interpretation is based on turbid or no color of mucus is considered as normal while light yellow color, yellow color, dark yellow color indicating mild, moderate and severe Endometritis, respectively.

Novel test device Metricheck

Device Metricheck that is inserted into the vagina and then examined the relationship between the metricheck clinical score at 35 days before the start of breeding. Cows with a history of a peripartum disease were examined by the metricheck device. To give endometritis clinical score the vaginal mucus can be scored for 0- Clear or translucent, mucus, 1- Clear or translucent mucous containing flakes of white pus, 2- <50 ml exudate containing<50 % white or cream pus and 3- >50 ml exudate containing >50% white, cream or bloody pus with foetid odour (McDougall et al., 2007).

Cytobrush

A valid alternative to detect uterine infection in cows and buffalo (Babu et al., 2013) could be the cytological evaluation of uterine fluids collected by aspiration of uterine contents or uterine lavage using a cytobrush or Foley catheter. The proportion of polymorphonuclear cells was significantly higher in buffalo with endometritis (45.62%) and so were the neutrophil counts (Babu et al., 2013). The practical utility of such a technique suffers from a lack of proportion of uterine cells diagnostic of endometritis in cows (Purohit et al., 2015) due to wide variation in the proportion...
of cells on different days postpartum and thus the technique has not become popular among clinicians.

**Treatment**

Endometritis is often self-limiting with recovery occurring after subsequent estrous cycles (Arthur *et al*., 1989). The effective treatment is one which increases the uterine defense and excludes bacterial infections but should not inhibit the normal UDM and should not cause further adulteration of milk or meat for human consumption. (Paisley *et al*., 1986). Early treatment of endometritis leads to better conception rates and shorter calving intervals in herds that suffer from the condition. Treatment success rates are higher for mild cases and those with a foul-smelling odor (Sheldon *et al*., 2006). The therapeutic of endometritis are as

**Hormonal**

Use of PGF\(_{2\alpha}\) and its analogues have been used as a treatment in cows (Paisley *et al*., 1986) PGF\(_{2\alpha}\) alone (Rao *et al*., 2001) or in combination with uterine lavage (Ahmadi *et al*., 2007) has been documented as alternative therapy for endometritis in dairy animals (Rao *et al*., 2001). Sharma *et al*., (2010) reported better result in endometritis by using cloprostenol and povidone iodine combination as compared to cloprostenol and povidone iodine alone.

**Estrogen**

Estradiol benzoate can be given 5 to 6 mg i/m during early post-partum period (after 6 days). It is a reliable treatment of cows with moderate post-partum uterine infection with or without retention of fetal membranes.

**Antiseptic**

Weak or dilute Lugol’s iodine solution has been reported to be an effective treatment of endometritis (Zemjans, 1980). An antiseptic solution has been reported to be an effective treatment of chronic endometritis Gentle flushing of large quantities of warmed saline into the uterus and subsequent siphoning may help remove some uterine content, although this has not been extensively validated (Sheldon *et al*., 2002).

**Intrauterine antibacterial**

The Oxytetracycline and Cephalosporins are broad spectrum and effective in the uterine environment and should be considered as the drug of choice. (Sheldon *et al*., 2002). While Tejbirsingh, (2006) reported 90 % recovery from endometritis in cow by using Ranvadone-iu as compared to 70 % (wokadine), 50 % (terramycine and lixen-iu) and 40 % (Furan).

**Immunomodulators**

It is a substance when infused into the uterus initiate a local immune system. (Dhalfiwal *et al*., 2004). These substances are

**Oyster Glycogen**

1.0 To 10.0 % oyster glycogen leads to leucocytosis in uterine lumen. Intrauterine infusion of oyster glycogen 500mg lead to marked improvement in the non-specific uterine defense and endometrial histopathological picture of cows with acute and chronic endometritis. The bacterial load was almost cleared by 72 hrs of the treatment and conception rate improved tremendously (Sabandria *et al*., 2000).

**E.coli Lipo polysaccharide (E.coli Endotoxine, E.coli LPS)**

E.coli LPS and bacteria free filtrate of streptococci infusing to uterus effectively increased the influx of PMN into uterus by Chemotaxis (Williamson *et al*., 1987). Chemotaxis of PMNs to uterine lumen has been reported to play an important role in the pathogenesis and resolution of endometritis (Asbur and Hansen, 1987). LPS also lead to influx of immunoglobulin helping in phagocytosis and killing of bacteria by cytokines, chemokines and antimicrobial peptides. It is observed that 100mg of LPS intrauterine will give very good result in such cases (Sheldon *et al*., 2009). PMNs activation by endotoxin is still unclear. It is assumed that endotoxin may increase neutrophil influx to uterus through stimulation of interleukins (IL-1) produced by monocytes and macrophages (Sica *et al*., 1990). Very good - 100mg of LPS intrauterine when used in cases of endometritis (Saini *et al*., 1999).

**Serum, Plasma and hyper immune serum**

Addition of a small amount of serum to uterine secretion could increase the opsonizing capacity and significantly enhance the phagocytic ability of equine PMNs. (Hussaine and Daniel, 1992) 50-100ml of autologus plasma for 3 days can be given in the uterus (Ganz *et al*., 1985).

**PMN extract and Component**

The primary and secondary granules (present in neutrophils cytoplasm) enzymes are bactericidal in nature. 100% killing of bacteria from equine uterus by PMN extract from rabbit origin. (Hughes and Couto, 1988). Human PMNs extract contain peptides (defensin), which are bactericidal in nature (Ganz *et al*., 1985).

**Granulocyte-Macrophage colony stimulating factor (GM-CSF)**

This is one of those glycoproteins (lymphokines) which helps in the differentiation and proliferation of certain hemopoietic cells and particularly help in formation of mature PMN colonies or macrophages or both. GM-CSF play important roles in body defense against microbial infection as it stimulates neutrophils, increases their phagocytic ability, inhibits their migration and makes more adherent to the bacteria (Hussain and Daniel, 1992).

**Enzyme: Lysozymes**

Therapeutic use of lysozyme with better conception rate (Dembinski *et al*., 1994). Cows in group enzyme received an intrauterine treatment with 4 mg of lysozyme (Himedia lab. Ltd.). Enzyme diluted in 40 ml of normal saline was infused for 2 consecutive days. The uterine wall was noticed
to be thin and having normal fleshy consistency after 3 days of treatment. The buffalo was bred with frozen semen after skipping of one estrous cycle. After 60 days, buffalo was declared positive for pregnancy by per rectal palpation. (Sadasivaraa et al., 2006). Solomon et al, (2009) reported extremely decrease in bacterial count and increase recovery rate (83.3 %) and conception rate (53.3 %) by using intra uterine immune modulators in endometritis affected bovine compared to phosphate buffer saline (50 ml), lysosomes (2 mg), oyster glycogen (1 %).

Herbal

Replanta is help in the treatment of endometritis without any side effect or decrease in milk production (Bhatia, 1980) Exapar (Dabar Ayurved Ltd.) is to be very effective in uterine involution(Honnappagol,1999) Utrovet forte bolus is use in the treatment of endometriti (Bajaj et al.,2002). Harendra kumar et al. (2009) reported 75 % and 67 % conception rate by using 40 ml Garlic extract and 40 ml neem oil dissolved in 40 ml normal saline intrauterine, three times at 24 hr. interval in endometritis affected buffaloes, respectively.

CONCLUSION

Uterine infection is common in bovine after parturition and causes considerable infertility. Endometritis is prevalent in dairy herds and contribute to increased days to first breeding, decreased conception rate and pregnancy rate and increased service per conception. PGF$_{2α}$ in combination with intrauterine antibacterial is drug of choice in the treatment of chronic endometritis. Now a days immunomodulators and different herbal agents can be utilize to decrease bacterial load in uterus. However, Roberts (1986) noted that until experiments are performed to compare the various treatments it is not possible to state which is superior. Bovine endometritis is a challenge to veterinary science and remains a complex entity for its diagnosis and treatment. Thus, there is a need for farmers, researchers and dairy vets to adapt new strategies with the aim of reducing incidences contributing to declining fertility in dairy herds.

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