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Nutritional Determinants and Surgical Interventions for Vaginal Prolapse in Ruminants: A Comprehensive Review

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I. Abstract

In ruminants, VP is a serious and important reproductive disease, which is a major problem for veterinary practitioners and livestock producers around the world. This review summarizes the multifactorial nature of VP, moving away from the mechanical understanding of VP and towards a more integrated biological understanding of VP. It examines the complex interactions between hormonal changes in late gestation (estrogen/relaxin axis) and the metabolic factors responsible for subclinical hypocalcemia and Dietary Cation-Anion Difference (DCAD) disorders. The paper outlines multiple surgical procedures from the conservative approach of the Buhner technique to the more permanent cervicopexy of the Winkler and assesses their biomechanical effectiveness. In addition it stresses the importance of the optimization of nutritional profile after surgery and genetic selection as two factors to prevent recurrence. This review will act as a guide to minimizing the economic costs and welfare of affected ruminants by combining surgical skills with metabolic control.

Keywords: ***Vaginal Prolapse, Ruminants, Buhner's Technique, Subclinical Hypocalcemia, DCAD, Pelvic Anatomy, Reproductive Management.***

II. Introduction:

In the modern ruminant production systems, the goal of maximizing milk production, optimized weaned weight, and reproductive efficiency has led to an increasing number of complex metabolic and reproductive diseases which pose challenges to the sustainability of ruminant production systems (Ding et al., 2024). In the past, the clinical view of this problem was that it was a purely mechanical or anatomic failure and was simply a matter of "tissue out of place" and therefore required physical manipulation and temporary stabilization. But now, the veterinary paradigm has changed: Vaginal prolapse is no longer considered an isolated accident but rather a complex multifactorial disorder that is a key clinical marker of the more serious systemic collapse and physiological imbalance (Zumrutbas 2025).

The underlying cause of this syndrome is the biological nature of late gestation when the ruminant body is a stage for intense physiological and metabolic competition (Law et al.,2024). In the last three months of pregnancy, the growing fetus is placing a tremendous and irrefutable demand for minerals, especially calcium, and phosphorus, which are being used to build the baby's skeletal tissue (Karpf et al., 2024). At the same time, there is an intense metabolic drain, together with the release of large amounts of estrogens in the placenta, along with the systemic release of relaxin, hormones specifically

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designed to trigger the remodeling of collagenous structures in the reproductive tract in preparation for parturition. In healthy animals this priming naturally causes softening of the pelvic tissues, which is necessary and also desirable; in other animals, however, a lack of metabolic supply, compared to the physiological demand, leads to pathological softening of pelvic tissues, or laxity, as Esposito et al., (2025) describe it. In these states, the vaginal wall is not structurally sound enough and because of the increasing intra-abdominal pressure due to a heavy gravid uterus and a physically distended rumen, the perivaginal connective tissues and the muscular pelvic diaphragm are unable to cope (Peter & King., 2021)..

In addition, this mechanical failure is rarely isolated, but is frequently complicated by the secondary effects of a local injury and environmental exposure. When the vaginal mucosa is exposed, even partially, it is exposed to the drying effect of the air, the presence of feces and the physical irritation it suffers, immediately provoking an inflammatory reaction (Oliveri 2017). This inflammation leads to severe oedema, and the tissues become heavier and more difficult to retract, causing a vicious circle of involuntary straining (tenesmus) which will in turn push the pelvic viscera out. Such structural failure has a broad impact on the individual animal's welfare, as well as a substantial economic and welfare impact on the worldwide level (Wiig, 2011) .To the producer it represents an ultimate loss of genetic and financial potential because of immediate veterinary costs, high surgical fees, reduced productivity, and indirect, but equally devastating costs associated with fetal death caused by separation of the placenta, compression of the umbilical cord, or maternal toxemia (Jonker, 2004).

The primary cause of acute discomfort and chronic pain to the animal is vaginal prolapse, and if the exposed tissues necrotize, it can be a door to systemic sepsis. Historically, only mechanical replacement of the organ, and the use of crude sutures, have been considered. This is often called the "quick fix" and is regarded as scientifically incomplete and a key factor in the high recurrence rates and poor long-term outcomes (Hakkarainen et al.,2014). Successful clinical results in today's world demands a comprehensive approach that connects the operating table and the feed bunk. This requires a paradigm change in veterinary medicine, moving beyond the focus on repairing visible symptoms and putting the emphasis on the underlying cause by thoroughly analyzing all the nutritional, metabolic, and environmental factors (Akintan et al., 2024).

Furthermore, the interrelationship of environmental influences, for example, topographical difficulties in grazing systems where animals are required to traverse steep terrain, and the genetic characteristics of some high producing lines should be carefully assessed to give a complete picture for an effective management plan. Some of these factors, including subclinical hypocalcemia, dietary cation-anion difference (DCAD) imbalances and even the estrogenic content of certain forages need to be incorporated into the diagnostic framework (Couto Serrenho 2020). The purpose of this review is to integrate the most recent developments in the field of surgical topography and nutritional biochemistry to build a strong and consistent basis for the management of vaginal prolapse with a focus on vaginal prolapse for immediate survival and long-term reproductive viability. The comprehensive nature of the approach not only resolves the immediate anatomical problem but also strengthens the animal's physiological resistance to future reproductive issues and maintains the genetic health and productivity of the herd in a challenging agricultural environment.

2. Advanced Surgical Anatomy of the Ruminant Pelvis

Very good knowledge of the pelvic diaphragm is crucial for a successful surgical intervention. A functional unit of muscles and ligaments (Martinelli et al.,2025) is responsible for the retentive

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2.1. Muscular Support

M. Levator Ani: Main muscle of the pelvic floor, which offers support to the sides and back of the vaginal wall.

M. coccygeus: Resists caudal pressure and works together with the levator ani to create the pelvic diaphragm.

Constrictor Vulvae: The last line of defense against prolapse. The main cause of Grade II prolapse is when it relaxes. (Routzong et al.,2022)

2.2. Ligamentous Framework

Relaxin causes the Sacrosciatic Ligaments to undergo tremendous remodeling. The density of collagen decreases and is replaced by a more hydrated extracellular matrix, which is "loose. One of the characteristics of chronic cases is pathological laxity of these ligaments (Chen et al., 2025).

3-Nutrient and metabolic factors.

3.1. Hypocalcemia

Smooth muscle contractility requires calcium ions (Ca2+). Uterine and vaginal atony are a result of subclinical hypocalcemia. If the muscles are not toned, the vagina becomes a passive organ and becomes easily pushed by the building up of pressure within the abdomen (Chetan Kumar et al.,2025).

3.2. The DCAD and Mineral Influence

Metabolic alkalosis lowers the sensitivity of Parathyroid Hormone (PTH) receptors, caused by diets rich in Potassium (K), so that the calcium can't be mobilized efficiently.

Trace Elements: Zinc, Copper, are co-factors for enzymes that are responsible for collagen cross-linking. Deficiency results in defective connective tissue.

Vitamin A & E: Important for epithelial integrity and against oxidative stress to the membranes. (Wagner et al.,2023)

4-The clinical classification and diagnosis of a disease.

The surgical prognosis is critically dependent on correct classification:

• Grade II: Weeping visible when pulled down.• Grade III: Weeping visible in a relaxed posture.

Grade II: Protrusion of the vaginal floor that continues throughout pregnancy.

Grade III: Complete eversion of the vagina and cervix, which may include the retroflexion of the urinary bladder.

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Grade IV: Long-term exposure causing necrosis of the mucous membranes and possible sepsis. (González-Martín et al., 2026)

5-Comprehensive Pharmacological Protocol (Dorn 2023)

Drug	**Dosage**	**Administration**	**Clinical Purpose**
Lidocaine 2%	1 ml / 100 kg BW	Caudal Epidural	Abolishes the straining reflex for replacement.
Flunixin Meglumine	2.2 mg/kg	IV (Daily for 3 days)	Controls pain and visceral tenesmus.
Meloxicam	0.5 mg/kg	SC or Oral	Long-term analgesia (Longer half-life).
Oxytetracycline LA	20 mg/kg	IM	Manages mucosal infection and necrosis.

Caudal is the usual technique, but in aggressive animals, systemic sedation must be carefully monitored and can result in a reduction in heart and respiratory rates during recovery due to the potential for synergistic effects following injection of multiple drugs (Abduljaleel et al., 2025).

The choice of antimicrobials to be given after surgery must take into account the potential histopathological side effects since some antimicrobials such as streptomycin may cause structural changes in immune organs and modulate macrophage activity (Mohsin et al., 2025).

6-Surgical Interventions: A Comparative Analysis

6.1. Buhner's Technique

Using a Buhner needle to place a subcutaneous tape around the vulva.

Biomechanical Principle: A surgical treatment for the weakened constrictor vulvae by creating an artificial sphincter.

WARNING: Must be loosened prior to labour to prevent vulva mutilation (Jordan 2025).

6.2. Minchev’s Vaginopexy

Fusing the cranium of the vagina to the sacrosciatic ligament.

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Pros: It is permanent, and you can have children naturally.

However, the following are the cons: there is a possibility of injury to the sciatic nerve if the needle placement is not correct (Chen et al.,2025).

6.3. Winkler's Cervicopexy

Tying the cervix to the prepubic tendon. Reserved for elite breeding stock because it is technically challenging, but has the least recurrence rate (Newcomer 2022).

7-Obstetric implications: Ringwomb and Inertia

Chronic irritation from prolapse leads to scarring and thus to a failure to dilate the cervix (cervical Dystocia/Ringwomb). The only solution is often then to resort to a C-Section (Kafi et al., 2024).

Uterine Inertia: Results from a state of metabolic exhaustion and weak uterine contractions, sometimes necessitating the use of Oxytocin after the full cervical dilation has occurred.

8. After Surgery and Management of Herds

1. Dietary Change: Make dietary switch to high quality low bulk concentrates which reduce the fill of the rumen.

2. There is a genetic component to VP. Bulls should not be bred to produce progeny that are affected and females should not be bred to produce affected offspring (Cowley et al.,2023).

Emerging technologies like Advanced Tissue Regeneration and Mucosal Healing, such as Platelet-Rich Fibrin (PRF), hold promise for faster tissue repair and avulsion wound healing in chronic mucosal trauma situations (Ibrahim et al., 2025).

III. Conclusion

Management of vaginal prolapse in ruminants is an example of the convergence of surgical technique and internal medicine. VP is not a random occurrence, it's a symptom of a deeper metabolic and genetic problem. Resolution will depend on a two-stage approach: surgical replacement immediately, and aggressive metabolic correction to restore smooth muscle tone. Outdated thinking surrounding "repair only" is no longer applicable and only an overall stabilization of the animal and its environment should be aimed for.

9. Practical Recommendations

1-Metabolic Monitoring: Check serum calcium level routinely on "close-up" animals.

2. Nutritional Precision: Follow Negative DCAD diet and maintain proper Zinc and Vitamin A levels.

Surgical Selection: Avoid low value stock, for vaginopexy.

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Pharmacological Support: Post Surgery use systemic NSAID to maintain "quiet" pelvis.

5. Genetic Integrity: Keep very close records and cull predisposed lines.

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