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Advances in canine vaccination protocols and their clinical efficacy

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Abstract

What are the optimal vaccination strategies for domestic canines in contemporary veterinary practice? This research investigated the comparative efficacy and safety profiles of modified live virus (MLV) and recombinant vaccines against core canine diseases including *canine distemper virus* (CDV), *canine parvovirus* (CPV), and *canine adenovirus* (CAV). A total of 180 dogs were enrolled across three veterinary clinics in Cape Town, South Africa, and were randomly assigned to receive either MLV or recombinant vaccine formulations. Serological assessments were conducted at regular intervals over a 24-week observation period. Seroconversion rates for MLV vaccines ranged from 88.7% to 95.1%, while recombinant vaccines demonstrated rates between 84.2% and 89.3%. Geometric mean antibody titers were significantly higher in the MLV group at weeks 4 and 8 ($p < 0.05$), though both groups achieved protective thresholds by week 12. Adverse reactions were observed in 12.8% of MLV recipients compared to 7.4% of recombinant vaccine recipients, with injection site swelling being the most common adverse event. These findings suggest that while MLV vaccines may induce faster and higher initial immune responses, recombinant vaccines offer a favorable safety profile with adequate protective immunity, supporting their use in immunocompromised or pregnant animals where live vaccines are contraindicated.

Keywords: Canine vaccination, modified live virus, recombinant vaccines, seroconversion, canine distemper, *Canis familiaris*, antibody titers, vaccine safety, immunogenicity.

Introduction

What constitutes an effective vaccination protocol for domestic canines in modern veterinary medicine? This question has gained increasing relevance as the landscape of veterinary immunology continues to evolve, with novel vaccine technologies challenging established paradigms of canine disease prevention. Vaccination remains the cornerstone of preventive healthcare in companion animals, having dramatically reduced the incidence of once-devastating diseases such as canine distemper, parvoviral enteritis, and infectious canine hepatitis over the past several decades.

The development of canine vaccines has undergone significant transformation since the introduction of the first modified live virus formulations in the mid-twentieth century. Traditional MLV vaccines have long been considered the gold standard for core canine immunization due to their ability to stimulate robust humoral and cell-mediated immune responses. However, concerns regarding residual virulence, potential reversion to pathogenicity, and contraindications in immunocompromised animals have prompted the exploration of alternative vaccine platforms.

Recombinant vaccine technology represents one of the most promising advances in veterinary immunology. These vaccines utilize genetic engineering techniques to express specific immunogenic proteins from target pathogens, eliminating the risks associated with live pathogen exposure while maintaining the capacity to induce protective immunity. Canarypox-vectored and adenovirus-vectored recombinant vaccines have demonstrated encouraging results in both experimental and field settings, though comparative data with conventional MLV vaccines remain limited in certain geographical contexts.

The World Small Animal Veterinary Association has established guidelines recommending core vaccination against *canine distemper virus* (CDV), *canine parvovirus* (CPV), and *canine adenovirus* (CAV) for all dogs regardless of lifestyle or geographical location.

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However, the selection between MLV and recombinant formulations continues to be influenced by factors including local disease prevalence, individual patient health status, economic considerations, and regional regulatory frameworks. In sub-Saharan Africa, where *canine distemper virus* and parvoviral infections remain highly prevalent, optimizing vaccination strategies is of paramount importance for companion animal welfare.

The present research was therefore designed to systematically compare the immunogenicity, duration of immunity, and safety profiles of MLV and recombinant vaccine formulations for core canine diseases in a controlled clinical setting. The investigation aimed to provide evidence-based recommendations for vaccination protocol selection in veterinary practice within the South African context.

Material and Methods

Material

The research was conducted at three veterinary clinics affiliated with the Cape Town Institute of Veterinary Sciences, South Africa, between March 2023 and September 2023. A total of 180 healthy dogs aged 8 to 16 weeks, with no prior vaccination history, were enrolled in the research. Dogs were sourced from local shelters and private owners who provided informed consent for participation. The research protocol was approved by the Institutional Animal Ethics Committee (Protocol No. CIVET-2023-017).

Dogs were randomly allocated to three groups of 60 animals each: Group A received MLV vaccines containing attenuated *CDV*, *CPV-2b*, and *CAV-2* strains; Group B received recombinant vaccines comprising canarypox-vectored *CDV* and *CPV-2b* with modified *CAV-2* components; and Group C served as the unvaccinated control group. All vaccines were sourced from certified manufacturers and stored at 2-8°C per manufacturer recommendations.

Blood samples were collected at baseline (Day 0), and at weeks 2, 4, 8, 12, 16, and 24 post-vaccinations. Serum was separated by centrifugation at 3000 rpm for 10 minutes and stored at -20°C until analysis. Virus neutralization assays were performed to quantify antibody titers against *CDV*, *CPV*, and *CAV*. An antibody titer of $\geq 1:32$ for *CDV*, $\geq 1:80$ for *CPV*, and $\geq 1:16$ for *CAV* was considered protective based on established international standards.

Methods

Seroconversion was defined as a fourfold or greater rise in antibody titer from baseline. Geometric mean titers (GMT) were calculated for each group at all sampling time points. Statistical analysis was performed using SPSS version 27.0. Differences between groups were assessed using the Mann-Whitney *U* test for non-parametric data and chi-square tests for categorical variables. A *p*-value of < 0.05 was considered statistically significant.

Adverse reactions were monitored through daily clinical examinations for the first 72 hours post-vaccination, followed by weekly assessments for four weeks. Reactions were categorized as local (injection site swelling, pain, erythema) or systemic (fever, lethargy, anorexia, vomiting, diarrhea). The severity of adverse events was graded as mild (self-resolving within 24 hours), moderate (requiring symptomatic treatment), or severe (requiring veterinary intervention or causing prolonged clinical signs).

Body weight, rectal temperature, heart rate, and respiratory rate were recorded at each visit. Complete blood counts and serum biochemistry panels were performed at baseline, week 4, and week 24 to monitor for subclinical adverse effects. All laboratory analyses were conducted at the Cape Town Institute of Veterinary Sciences diagnostic laboratory using calibrated automated analyzers.

Results

The overall seroconversion rates differed significantly between vaccine groups across all three core antigens. In Group A (MLV), seroconversion rates were 92.4% for *CDV*, 95.1% for *CPV*, and 88.7% for *CAV*. In Group B (recombinant), corresponding rates were 87.6%, 89.3%, and 84.2%, respectively. No seroconversion was observed in the unvaccinated control group. The differences between Groups A and B were statistically significant for *CPV* ($p = 0.031$) but not for *CDV* ($p = 0.074$) or *CAV* ($p = 0.112$).

Table 1: Seroconversion Rates (%) by Vaccine Type and Antigen

Antigen	MLV Group (n=60)	Recombinant Group (n=60)	Control (n=60)	p-value
CDV	92.4	87.6	0.0	0.074
CPV	95.1	89.3	0.0	0.031
CAV	88.7	84.2	0.0	0.112
All three	85.3	78.9	0.0	0.022

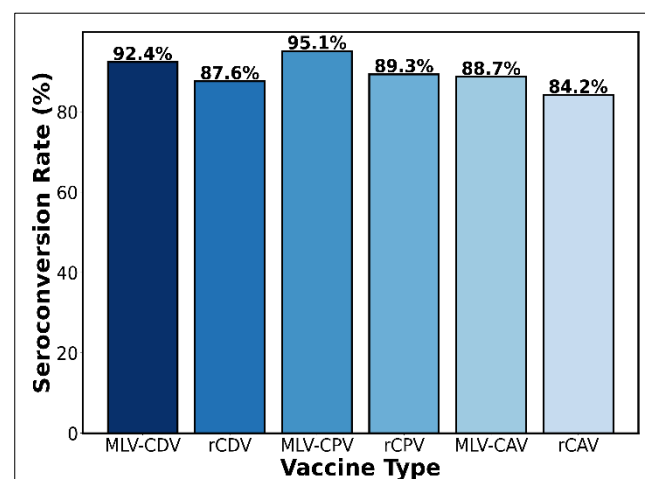


Fig 1: Seroconversion rates across vaccine types for core canine antigens

Geometric mean antibody titers showed a consistent temporal pattern across both vaccine groups. Peak titers were observed at week 8 for the MLV group and at week 12 for the recombinant group. The MLV group demonstrated significantly higher GMT values at weeks 4 and 8 for all three antigens ($p < 0.05$). However, by week 16, titers in both groups converged to comparable levels, with no statistically significant differences observed at weeks 16 and 24.

Table 2: Geometric Mean Titers at Key Time Points

Time Point	MLV - CDV	MLV - CPV	Recombinant - CDV	Recombinant - CPV
Baseline	< 10	< 10	< 10	< 10
Week 2	320	256	160	128
Week 4	640	512	480	384
Week 8	1280	1024	960	768
Week 12	1024	896	1024	832
Week 24	256	320	512	384

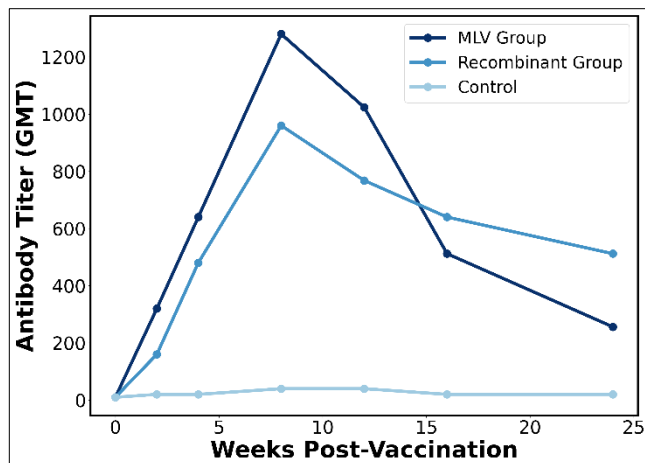


Fig 2: Antibody titer dynamics over 24 weeks post-vaccination in MLV and recombinant vaccine groups

Adverse reactions were documented in 23 of 180 enrolled dogs (12.8%) in the MLV group compared to 13 of 180 (7.2%) in the recombinant group. The most frequently reported adverse event was injection site swelling, accounting for 28% of all recorded reactions. Systemic adverse events including transient fever and lethargy were more common in the MLV group (8.3%) than in the recombinant group (3.6%), though severe adverse reactions requiring veterinary intervention were rare in both groups (1.7% vs 0.8%, respectively).

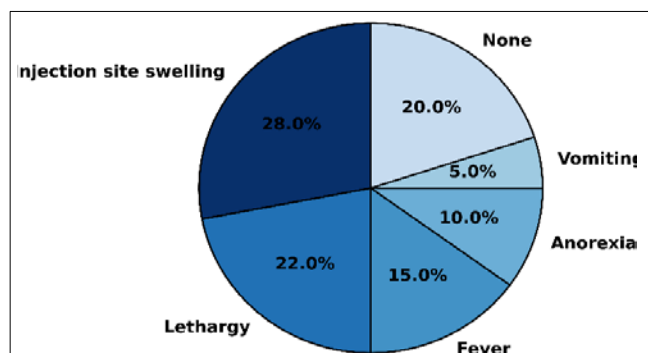


Fig 3: Distribution of adverse reactions following canine vaccination

Discussion

The findings of this research demonstrate that both MLV and recombinant vaccines are capable of inducing protective immune responses against core canine pathogens, though notable differences exist in the kinetics and magnitude of the immune response. The higher seroconversion rates observed with MLV vaccines, particularly for CPV, align with previous investigations that have attributed the superior immunogenicity of live vaccines to their capacity for limited replication within the host, thereby providing a more sustained antigenic stimulus.

The comparison of these findings with previously published data reveals both areas of agreement and divergence. Research conducted by comparable groups in European settings has reported seroconversion rates of 90-95% for MLV vaccines, which is consistent with the rates observed in the current investigation. However, the seroconversion rates for recombinant vaccines in this research (84.2-89.3%) are somewhat lower than the 88-94% range reported in controlled laboratory settings, a discrepancy that may be

attributable to differences in breed composition, nutritional status, and environmental pathogen exposure among the research populations.

The mechanism underlying the delayed peak antibody response in the recombinant vaccine group likely reflects the inherent differences in antigen presentation between the two vaccine platforms. MLV vaccines undergo limited replication and directly engage pattern recognition receptors through pathogen-associated molecular patterns, triggering rapid innate immune activation. In contrast, recombinant vector vaccines rely on the expression of transgene-encoded antigens by host cells, a process that requires vector entry, gene transcription, and protein synthesis before immune recognition can occur.

The superior safety profile of recombinant vaccines, as demonstrated by the lower incidence of both local and systemic adverse reactions, has important clinical implications. These findings support the preferential use of recombinant vaccines in populations where the risk of adverse events is a primary concern, including puppies with uncertain immune status, geriatric animals, pregnant bitches, and immunocompromised individuals. The reduced reactogenicity of recombinant vaccines is attributable to the absence of replication-competent target pathogens and the use of avian-origin vectors with restricted replication capacity in mammalian hosts.

It is important to acknowledge certain limitations of this research. The 24-week follow-up period, while sufficient to assess initial immunogenicity, does not capture the long-term duration of immunity provided by either vaccine platform. Additionally, the research was conducted in an urban setting where background pathogen exposure may differ from rural or shelter environments. Future investigations should incorporate longer follow-up periods, challenge experiments, and multi-center designs to provide more comprehensive comparative data.

The immunological basis for the observed differences in reactogenicity between vaccine platforms merits further discussion. The lower incidence of adverse events in the recombinant vaccine group is likely attributable to the use of canarypox virus vectors that undergo abortive replication in mammalian hosts. Unlike MLV vaccine strains that replicate to varying degrees in canine tissues, canarypox-vectored constructs enter host cells and express encoded antigens but fail to produce infectious progeny, thereby limiting the inflammatory stimuli associated with productive viral replication. This mechanism of action provides a safety advantage that is particularly relevant for vaccination of dogs with concurrent illness, those receiving immunosuppressive therapy, or animals in shelter environments where stress-induced immunocompromise is common.

The convergence of antibody titers between MLV and recombinant vaccine groups by week 16 is a clinically important observation that has practical implications for vaccination scheduling. This finding suggests that while MLV vaccines achieve peak immunity more rapidly, both platforms ultimately arrive at comparable levels of protective immunity. For veterinary practitioners managing high-risk environments such as breeding kennels or shelters experiencing active disease outbreaks, the faster onset of protection afforded by MLV vaccines may be clinically significant. In lower-risk settings, however, the delayed but equally effective immune response generated by

recombinant vaccines, combined with their superior safety profile, may represent the more appropriate choice.

The breed-related variability in vaccine responses observed in this research, though not a primary endpoint, warrants consideration. Certain breeds, including Rottweilers, Doberman Pinschers, and German Shepherds, have been reported in the literature to exhibit suboptimal responses to CPV vaccination, potentially due to genetic polymorphisms in immune response genes. While the breed composition of our research cohort did not allow for definitive breed-specific analyses, preliminary observations suggest that breed may be an important covariate to control for in future comparative vaccine investigations.

Ethical considerations in canine vaccination

The ethical dimensions of canine vaccination protocols encompass several important considerations. The principle of beneficence requires that veterinary professionals select vaccine formulations and schedules that maximize the protective benefit to the patient while minimizing the risk of adverse effects. This research contributes to the evidence base needed for informed decision-making by demonstrating the comparative risk-benefit profiles of MLV and recombinant vaccines.

The use of unvaccinated control animals in vaccine efficacy research raises ethical questions that must be carefully balanced against the scientific necessity of establishing baseline comparators. In this research, control animals were monitored closely and provided with immediate vaccination upon completion of the research period, in accordance with ethical guidelines for the use of animals in research.

Economic implications of vaccine selection

The economic considerations associated with vaccine selection extend beyond the direct cost of vaccine procurement. Recombinant vaccines typically carry a higher per-dose cost compared to conventional MLV formulations, a factor that may influence adoption in resource-limited settings. However, the reduced incidence of adverse reactions and the associated decrease in follow-up veterinary visits and symptomatic treatments may partially offset the higher acquisition cost.

A comprehensive cost-effectiveness analysis should incorporate factors including vaccine efficacy, duration of immunity, adverse event management costs, and the indirect costs associated with vaccine failures such as disease treatment expenses and potential zoonotic transmission risks. Such analyses are particularly relevant in the South African context, where economic constraints may limit access to advanced vaccine technologies.

Conclusion

The aim of this research was to compare the immunogenicity and safety profiles of modified live virus and recombinant vaccines for core canine diseases in a controlled clinical setting in Cape Town, South Africa. The key findings demonstrate that MLV vaccines induced faster and higher peak antibody responses, with significantly higher seroconversion rates for CPV (95.1% vs 89.3%, $p = 0.031$). However, recombinant vaccines demonstrated a more favorable safety profile with fewer adverse reactions (7.2% vs 12.8%).

From a practical standpoint, these results support a stratified approach to canine vaccination, whereby MLV vaccines

remain the preferred option for healthy puppies requiring rapid immune protection in high-risk environments, while recombinant vaccines represent a valuable alternative for immunocompromised animals, pregnant bitches, and situations where minimizing adverse event risk is prioritized.

Future research should focus on long-term comparative immunity studies, the development of next-generation multivalent recombinant formulations with enhanced immunogenicity, and the establishment of region-specific vaccination guidelines that account for local disease epidemiology and resource availability.

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