ARTICLES
Archives of Veterinary Science
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Rate of umbilical healing in newborn piglets: the influence of neonatal practices and birth weight

Submitted: *24/11/2025*
Accepted: *12/04/2026*

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Abstract: This study evaluated the effects of different umbilical cord care techniques in newborn piglets. A total of 212 piglets from 15 sows were allocated in a randomized block design. Treatments included: No Intervention (NI) – no intervention was performed in the cord at birth; Tying and Cutting (TC) – the cord was tied onto itself and cut below the knot; and String, Cutting, and Iodine (SCI) – the cord was tied with string, cut, and immersed in 10% iodine solution. The following variables were analyzed: colostrum intake, hemorrhage incidence, healing time, umbilical hernia incidence, growth performance. No treatment effects were found for colostrum intake, performance, hemorrhage incidence, or umbilical hernia occurrence. Piglets in the TC group showed a slightly shorter healing time than those in the NI and SCI groups (P = 0.035). Birth and weaning weights were negatively correlated with healing time—lighter piglets exhibited slower healing, whereas faster-healing piglets achieved higher weaning weights. In conclusion, additional umbilical care, such as iodine application, did not improve umbilical healing and performance. Under the conditions of this study, additional procedures, such as iodine application, did not confer additional benefits over a simple tying technique.
Keywords: Hernia, Pre-Weaning, Sus scrofa domesticus, Swine, Umbilical Outpouchings.

1. Introduction

In swine production systems, implementing management practices tailored to each production stage is essential to achieve optimal performance and reduce both productive and economic losses. The suckling phase, spanning from birth to weaning (typically 21-28 days of age), is considered one of the most critical stages of the production cycle, as it is associated with the highest mortality rate (Davidov et al., 2024). Previous research has shown that management practices during the pre-weaning period can influence performance traits, immune system development, and even meat quality later in life, ultimately impacting the overall profitability of pig production (Kwon et al., 2025). Given the vulnerability of neonatal piglets, producers place great emphasis on specific management practices — both preventive and therapeutic — implemented immediately after birth. These practices include ensuring thermal comfort and adequate colostrum and milk intake, as well as conducting health interventions such as iron supplementation, anticoccidial treatments, and vaccinations (Kumar et al., 2025).

Among these practices, umbilical cord management is particularly relevant. The umbilical cord connects the fetus to the placenta, enabling the transfer of nutrients and the elimination of waste during gestation (Manuel Barrios Arpi, 2019). It comprises essential vessels, such as the umbilical vein, the arteries, and the urachus, which connect the placenta to the liver, the aorta, and the bladder, respectively (Pinheiro et al., 2024). After birth, these vessels are expected to dry and close naturally, severing these connections. However, delayed healing can result in umbilical outpouchings (UO), which are primarily caused by hernias or abscesses with associated fibrosis (Hovmand-Hansen et al., 2021a).

In commercial farms, this procedure commonly includes tying the cord with a string, cutting it, and disinfecting it with an iodine-based solution (Robinson et al., 2016). Nevertheless, recent studies have questioned whether alternative, more effective approaches to umbilical cord care exist or whether such management is even necessary in farms with high sanitary standards and low environmental contamination (Hansen et al., 2024; Robinson et al., 2016). Therefore, the objective of this study was to compare different umbilical cord care management techniques applied at birth and evaluate their effects on piglets' colostrum intake, incidence of hemorrhage, healing time, incidence of umbilical hernias throughout the productive lifespan, and growth performance.

2. Materials and Methods

This experiment was approved by the Ethic Committee on Animal Use (CEUA) of the School of Veterinary Medicine and Animal Science (FMVZ) of the University of São Paulo (USP) (CEUA N° 4899180325). The study was conducted on the Swine Research Laboratory (LPS) at FMVZ/USP, located in Pirassununga (21°56'56.9" S 47°27'16.1" W), São Paulo, Southeastern Brazil.

2.1. Animals, Facilities, and Experimental Design

A total of 212 piglets from 15 third-parity sows (DB 90 line) crossed with LQ1250 boar, were used. The experiment was carried out in a conventional farrowing facility with curtain, controlled ventilation, and no automatic climate control. Thermal comfort for piglets was provided by 100 W heat lamps and heated floors in the creep area. Piglets in all treatments were dried using drying powder (Olmix, Campinas, Brazil) at birth and individually identified with ear tags. All pens were equipped with nipple drinkers for the piglets, and creep feed was provided from the seventh day of life until weaning. The sows were in good general health and body condition at farrowing, and all procedures were performed under the same sanitary management conditions adopted by the experimental farm. The experimental treatments consisted of: No Intervention (NI) - no intervention was performed on the umbilical cord; Tying and Cutting (TC) - the umbilical cord was tightly tied onto itself and cut below the tied area and; String, Cutting and Iodine (SCI) – the umbilical cord was tied with string, cut below the tied area, and immersed in 10% iodine. In the TC and SCI treatments, the umbilical cord was tied approximately 5 cm away from the piglet's abdominal wall.

2.2. Performance and umbilical cord analysis

Piglets were individually weighed at birth, at 24 hours of age, and at weaning using a digital scale (Welmy, Santa Bárbara d'Oeste, Brazil). Colostrum intake was estimated according to the predictive model described by Theil et al. (2024). To assess the occurrence of hemorrhages, piglets were observed twice daily from birth until the umbilical cord had healed and detached. Hemorrhage was classified as either positive (occurrence of hemorrhage in the cord) or negative (absence of hemorrhage in the cord). To determine the number of days required for complete healing and umbilical cord detachment, all piglets were evaluated daily. Hernia occurrence was recorded during the pre-weaning phase (0 to 21 days), the nursery phase (21 to 63 days), and the grow-finishing phase (63 to 167 days). The same experienced veterinarian performed all evaluations.

2.3. Statistical analysis

Data were analyzed using R software (version 4.2.1; R Core Team, Vienna, Austria). Normality and homoscedasticity were assessed both visually and through the Shapiro-Wilk and Bartlett tests, respectively. Performance data that did not meet the normality assumption were transformed using the Box-Cox method. Data were analyzed using mixed-effects models, with sow included as a random effect. Differences in mean values were considered significant at $P < 0.05$, and means were compared using the Tukey test. For umbilical outpouching, hemorrhages, and umbilical cord detachment, multivariable regression was performed using a stepwise forward selection approach. Logistic regression was used to analyze incidence data. Initially, each independent variable was tested in univariate models, and those with p-values ≤ 0.20 were selected as candidates for inclusion in the multivariable model. Variables were then sequentially added and removed based on their statistical contribution, with model selection guided by the lowest Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) values.

Throughout the model-building process, multicollinearity was assessed using the Variance Inflation Factor (VIF). Variables with VIF values above 5 were considered indicative of high collinearity and were carefully evaluated for removal to ensure model stability and interpretability. Final regression models only include variables with $P < 0.1$. Additionally, two Principal Component Analyses (PCA) were performed. Individuals were colored by experimental treatment, with 95% confidence ellipses computed around treatment centroids. Variable contributions were visualized using factor coordinates, and multivariate group differences were statistically tested via PERMANOVA.

3. Results

The different umbilical cord management techniques applied at birth did not affect body weight at 24 h, weight gain during the first 24 h, or pre-weaning weight (Table 1).

Variables	NI	TC	SCI	SEM	P-Value
Birth weight, kg	1.277	1.289	1.249	0.047	0.525
Weight at 24 hours, kg	1.286	1.314	1.264	0.047	0.507
Weight gain 0-24h, kg	0.009	0.021	0.016	0.015	0.860
Weaning weight, kg	6.658	7.033	6.755	0.359	0.552
Colostrum intake, g	314.038	310.373	306.873	18.358	0.936

NI: No Intervention group. **TC:** Tying and Cutting group. **SCI:** String, Cutting and Iodine group. **SEM:** Standard Error of the Mean.

Table 1 – Growth performance and colostrum intake of piglets submitted to different umbilical cord management approaches.

The results of the univariate analysis showed that treatment, birth weight, birth order, and sex did not influence the incidence of hemorrhage or umbilical hernias ($P > 0.20$). For umbilical healing, the univariate analysis indicated significant effects of treatment ($P = 0.035$), birth weight ($P = 0.016$), sex ($P = 0.077$), and colostrum intake ($P = 0.045$). However, sex ($P = 0.331$) and colostrum intake ($P = 0.380$) were excluded from the multivariate analysis, and the final model included treatment ($P = 0.051$) and birth weight ($P = 0.026$, supplementary material). The incidence of hemorrhage and umbilical hernias was not affected by the treatments (Table 2). However, piglets in the TC group had a shorter interval between umbilical cord management and healing time (- 7.25%) than

those in the NI and SCI groups (P = 0.035). Of the 16 umbilical hernias observed in this study, one (6.25%) was observed in the nursery phase, while the others were manifested in the finishing phase.

Variables	NI	TC	SCI	SEM	P-Value
Occurrence of hemorrhage, %	2.53	8.19	6.94	3.51	0.336
Interval between birth and umbilicus dropping, days	3.45a	3.20b	3.45a	0.135	**0.035***
Incidence of umbilical hernia, %	7.24	6.78	11.15	4.65	0.631

NI: No Intervention group. **TC:** Tying and Cutting group. **SCI:** String, Cutting and Iodine group. **SEM:** Standard Error of the Mean. Mean followed by different letters differ significantly between the treatments, using Tukey's test (α=0.05).

Table 2 – Occurrence of hemorrhage, umbilicus drop time and incidence of umbilical hernia of piglets submitted to different umbilical cord management approaches.

The PCA plot (Figure 1) showed that the first principal component accounted for 38.9% of the total variance, while the second principal component accounted for 21.3%. Both birth weight and weaning weight were negatively correlated with umbilical cord healing time, indicating that piglets with lower birth weights required longer umbilical cord healing. In contrast, those with faster umbilical cord healing achieved higher weaning weights. Birth weight was positively correlated with weaning weight and colostrum intake.

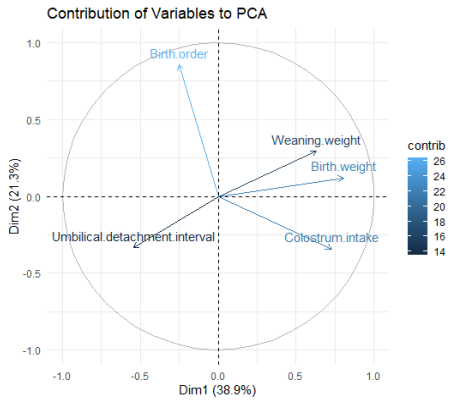

Figure 1 – Principal component analysis (PCA) plot showing the contribution of variables birth order, weaning weight, birth weight, umbilical detachment interval and colostrum intake of piglets submitted to different umbilical cord management approaches.

Figure 2 shows the distribution of the first (38.9%) and second (21.3%) principal components, which together explain 60.2% of the total variance in the treatment-related data. Although there was overlap among the three treatment groups, indicating limited overall separation, the TC group exhibited a subtle but consistent directional shift.

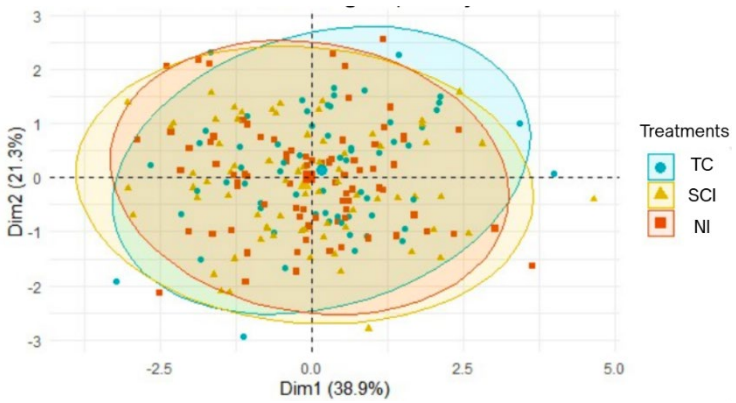

Figure 2 – Principal component analysis (PCA) plot showing the contribution of the treatments to the variables. **NI:** No Intervention group. **TC:** Tying and Cutting group. **SCI:** String, Cutting and Iodine group.

4. Discussion

Birth weight and early growth are fundamental indicators of piglet viability and performance potential. These variables are influenced, but not limited to, by litter size, colostrum intake, sow health status, and genetic background (Farmer and Edwards,

2022). Piglets from large litters generally exhibit greater birth weight variability, which can hinder access to colostrum and reduce weight gain on the first day of life (Quesnel et al., 2023). Heavier piglets tend to be more vigorous, initiating suckling earlier and obtaining higher amounts of colostrum, which supports passive immunity and subsequent growth (Milligan et al., 2001; Nuntapaitoon et al., 2019).

In the present study, although no significant differences in performance were observed among treatments, a positive correlation was identified between birth weight, colostrum intake, and weaning weight. This reinforces the role of initial body weight as a predictor of postnatal development. Similar relationships have been described by Kwon et al. (2025), who reported that heavier piglets at weaning show improved growth and feed efficiency in the nursery phase. The absence of differences among groups suggests that none of the evaluated umbilical management practices impaired piglet performance, a relevant result from a practical standpoint, as it indicates that simpler handling practices did not negatively affect productivity. Contrary to expectations, no association between colostrum intake and healing time was observed, suggesting that the environmental and individual factors may exert greater influence. Both systemic and local factors influence the processes of umbilical and wound healing (Martin et al., 2016). Therefore, although passive immunity may indirectly contribute to healing by reducing the risk and severity of infection during this period, its effect is likely to be secondary.

In this study, birth and weaning weights were negatively correlated with healing time, indicating that lighter piglets required longer to heal the umbilicus. This could be explained by the fact that piglets with low birth weight may exhibit impaired transfer of antibodies and neonatal immune cells, which negatively affects both the initial inflammatory response and tissue regeneration mechanisms, thereby directly interfering with umbilical cord healing. This finding can be explained by the observations of Hovmand-Hansen et al. (2021a), who reported that piglets born immature are more likely to develop UO due to the immature structure of their tissues. Additionally, lighter piglets often experience difficulties with thermoregulation, which can further compromise cellular metabolism involved in healing processes (Devillers et al., 2011; Ferrari et al., 2014). Prolonged healing may increase vulnerability to infection because the exposed umbilical stump remains a potential entry point for pathogens (Barington et al., 2024; Blirup-Plum et al., 2025). Environmental hygiene and thermal conditions also affect healing rates, as contaminated or cold environments can delay cord drying and increase bacterial colonization (Schokker et al., 2014).

Umbilical hernias are an important welfare and economic concern, being associated with carcass condemnation, secondary infections, intestinal torsions, and, in severe cases, mortality (Straw et al., 2009; Yun et al., 2017; Hovmand-Hansen et al., 2021b; Nowacka-Woszuk, 2021). Different umbilical cord management strategies did not affect the incidence of hernias. This result was expected, primarily due to the low incidence of umbilical hernias, but also considering that factors reported as important for hernia development, such as pre-weaning weight gain, early immunity (acquired through colostrum intake), and the presence of infections during the pre-weaning period, did not differ among treatments (Hovmand-Hansen et al., 2021a; Searcy-Bernal et al., 1994). Previous studies have reported that delayed cord drying may favor hernia formation by maintaining local humidity and promoting bacterial growth (Hovmand-Hanses et al., 2021b). In a study by Hovmand-Hansen et al. (2021b), it was reported that more than half of pigs with hernias or other umbilical lesions either died or were euthanized before reaching slaughter weight, directly impacting productivity.

Although the faster healing observed in the TC group should be interpreted with caution, given the small effect size, it remains an interesting result. It may serve as a starting point for future studies on UO prevention. Moreover, although the farrowing phase accounts for only 15–20% of the piglets' lifespan, it is the period with the highest mortality rate (Davidov et al., 2024), underscoring the importance of even small management practices to reduce losses.

All management practices implemented in commercial pig farms require both resources and labor. In the present study, additional umbilical care practices—such as cord tying or iodine application—were not effective in preventing umbilical hernias, suggesting that such practices may be unnecessary. It is important to note that genetic factors, environmental conditions, and individual characteristics of sows and piglets may influence these outcomes. Therefore, the specific context of each farm should be carefully evaluated before adopting or discontinuing disease prevention strategies. The results also emphasize the strong influence of birth weight on healing and performance, underscoring the importance of farrowing management strategies to improve neonatal vitality and uniformity.

5. Conclusion

Under the conditions of this study, adopting additional umbilical care practices, such as tying with a string and applying iodine solution, was not effective in reducing hemorrhage, shortening healing time, preventing umbilical hernias, or improving productive parameters. Simply tying the umbilical cord to itself significantly accelerated healing. Overall, the findings highlight that birth weight plays a greater role than umbilical cord treatment in influencing healing time and early performance. The data emphasize the need for management practices that improve piglet vitality and uniformity at birth.

Acknowledgments: To Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP, Brazil), grant numbers: 2025/07008-4, 2025/05582-5; 2024/20074-3; 2024/21519-9; 2024/10939-7; 2021/08217-5, Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES, Brazil), grant number: 001, and Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq, Brazil), grant number: 304257/2024-9.

Briefing notes: This study was approved by the Ethic Committee on Animal Use (CEUA) of the School of Veterinary Medicine and Animal Science (FMVZ) of the University of São Paulo (USP), under the protocol CEUA N° 4899180325 (September 4th of 2025).

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