Suitability of four injectable anesthetic protocols for percutaneous synovial fluid aspiration in healthy swine under field conditions and assessment of lameness seven days post procedure

Paisley Canning, DVM, PhD; Katie O'Brien; Victoria Thompson; Darin Madson, DVM, PhD, Diplomate ACVP; Kristin Skoland; Alejandro Ramirez, DVM, MPH, PhD, Diplomate ACVPM; Daniel Linhares, DVM, MBA, PhD; Phillip Gauger, DVM, PhD; Locke Karriker, DVM, MS, Diplomate ACVPM

Summary

Objective: To compare the suitability of four anesthetic protocols for ante-mortem percutaneous synovial fluid aspiration from healthy swine in field conditions. A supplemental objective was to assess the iatrogenic impact of ante-mortem joint sampling by monitoring lameness and joint swelling after the procedure and assessing synovium histology at day seven post treatment.

Materials and methods: Twenty-four finisher pigs (mean weight 86.1 kg ± 10.6) were each randomly allocated to receive one of four intramuscularly administered anesthetic protocols: telazol-ketamine-xylazine (TKX); telazol-ketamine-acepromazine (TKA); ketamine-acepromazine with lidocaine epidural (KAL); or telazol-acepromazine with lidocaine epidural (TAL). Synovial fluid was collected aseptically from one carpus and tarsus joint per anesthetized pig. The anesthetic protocols were evaluated in terms of successful general anesthesia, time to sternal recumbency and time to standing recovery, and protocol cost. Joint swelling and lameness assessments were completed on days two, four, and seven post sampling. On day seven, pigs were euthanized and synovium was collected from each sampled joint for histologic evaluation.

Results: The TKX and TAL treatments were the only anesthetic combinations that provided an adequate anesthesia depth for fluid collection to occur. Mean (SD) time to sternal recumbency for TKX was 125 (26) minutes and for TAL was 198 (28) minutes. There was no evidence of post-aspiration infection in any sampled joints.

Implications: The TKX treatment was the most effective anesthetic protocol for ante-mortem joint fluid collection. Ante-mortem joint fluid collection was not associated with significant joint tissue damage and can be a useful diagnostic tool for infectious arthritis.

Keywords: swine, synovial fluid, telazol, ketamine, xylazine

Received: June 26, 2017
Accepted: November 11, 2017

Resumen – Evaluación de la aptitud de cuatro protocolos de anestesia inyectable para la aspiración percutánea de fluido sinovial en cerdos sanos bajo condiciones de campo y valoración de la cojera siete días después del procedimiento

Objetivo: Comparar la aptitud de cuatro protocolos de anestesia para la aspiración percutánea ante-mortem de fluido sinovial de cerdos saludables en condiciones de campo. Un objetivo suplementario fue valorar el impacto iatrogénico del muestreo ante-mortem de la articulación mediante el monitoreo de la cojera, y la inflamación de la articulación después del procedimiento, así como valorar la histología sinovial en el día siete post tratamiento.

Materiales y métodos: Se repartieron al azar, veinticuatro cerdos de finalización (peso promedio 86.1 kg ± 10.6) para recibir uno de cuatro protocolos de anestesia administrada intramuscularmente: zelazol-ketamina-xilazina (TKX por sus siglas en inglés); zelazol-ketamina-acepromazina (TKA por sus siglas en inglés); ketamina-acepromazina con epidural de lidocaína (KAL por sus siglas en inglés); o zelazol-aceproma¬zina con lidocaína epidural (TAL por sus siglas en inglés). En cada cerdo anestesiado, se recolectó asépticamente fluido sinovial de una articulación del carpo y del tarso. Se evaluaron los protocolos anestésicos en términos de anestesia general exitosa, tiempo de recumbencia esternal, tiempo para recuperación de pie, y costo de protocolo. Se hizo la valoración de la inflamación de la articulación y cojera en los días dos, cuatro, y siete post muestreo. En el día siete, se realizó la eutanasia de los cerdos y se recolectó la sinovia de cada articulación muestreada para la valoración histológica.

Resultados: Los tratamientos TKX y TAL fueron las únicas combinaciones que alcanzaron una anestesia profunda adecuada para que se hiciera la recolección del fluido.

PC, KOB, VT, KS, AR, LK: Swine Medicine Education Center, College of Veterinary Medicine, Iowa State University, Ames, Iowa.

DM, PG: Veterinary Diagnostic Laboratory, Iowa State University, Ames, Iowa.

AR, DL: Veterinary Diagnostic and Production Animal Medicine, College of Veterinary Medicine, Iowa State University, Ames, Iowa.

Corresponding author: Dr Locke Karriker, Swine Medicine Education Center, Iowa State University College of Veterinary Medicine, 2412 Lloyd Veterinary Medical Center, Ames, IA 50011; Tel: 515-294-2283; Fax: 515-294-1072; E-mail: karriker@iastate.edu.

This article is available online at http://www.aasv.org/shap.html.

https://doi.org/10.54846/jshap/1050

Canning P, O'Brien K, Thompson V, et al. Suitability of four injectable anesthetic protocols for percutaneous synovial fluid aspiration in healthy swine under field conditions and assessment of lameness seven days post procedure. *J Swine Health Prod.* 2018;26(3):130-136.

El tiempo promedio (SD por sus siglas en inglés) para la recumbencia esternal con TKX fue de 125 (26) minutos y con TAL de 198 (28) minutos. No hubo evidencia de infección post aspiración en ninguna de las articulaciones muestreadas.

Implicaciones: El tratamiento de TKX resultó ser el protocolo anestésico más efectivo para la recolección ante-mortem de fluido de articulación. La recolección ante-mortem de fluido de la articulación no se asoció con daño significativo en el tejido de la articulación y puede ser una herramienta de diagnóstico útil para la artritis infecciosa.

Résumé – Pertinence de quatre protocoles d'anesthésie par injection pour aspiration de liquide synovial chez des porcs en santé dans des conditions de terrain et évaluation des boiteries sept jours post-procédure

Objectif: Comparer la pertinence de quatre protocoles d'anesthésie pour l'aspiration transcutanée ante-mortem de liquide synovial de porcs en santé dans des conditions de terrain. Un objectif supplémentaire était d'évaluer l'impact iatrogénique de l'échantillonnage ante-mortem d'articulations en surveillant la boiterie et l'enflure des articulations suite à la procédure et en évaluant l'histologie de la synoviale sept jours après le traitement.

Matériels et méthodes: Vingt-quatre porcs en période de finition (poids moyen 86,1 kg ± 10,6) ont été répartis de manière aléatoire afin de recevoir un des quatre protocoles d'anesthésie par voie intra-musculaire: telazol-kétamine-xylazine (TKX); telazol-kétamine-acépromazine (TKA); kétamine-acépromazine avec lidocaïne en épidurale (KAL); ou telazol-acépromazine avec lidocaïne en épidurale (TAL). Du liquide synovial a été prélevé de manière aseptique à partir d'une articulation du carpe et du tarse de chaque porc anesthésié. Le protocole anesthésique était évalué en termes de succès de l'anesthésie générale, délai avant le décubitus sternal et délai pour retour à la station debout et coût du protocole. L'enflure de l'articulation et l'évaluation de la boiterie ont été réalisées au jour 2, 4, et 7 post-échantillonnage. Au jour 7, les porcs ont été euthanasiés et la synoviale prélevée de chaque articulation échantillonnée pour évaluation histologique.

Résultats: Les traitements TKX et TAL étaient les seules combinaisons d'anesthétiques qui fournissaient une profondeur d'anesthésie adéquate pour effectuer les prélèvements de liquide. Le temps moyen ± l'écart-type pour atteindre le décubitus sternal pour TKX était de 125 ± 26 min et pour TAL il était de 198 ± 28 min. Aucune évidence d'infection post-aspiration ne fut notée dans toutes les articulations échantillonnées.

Implication: Le traitement TKX était le protocole d'anesthésie le plus efficace pour le prélèvement ante-mortem de liquide articulaire. Le prélèvement ante-mortem de liquide articulaire n'était pas associé avec du dommage tissulaire significatif dans les articulations et peut être un outil diagnostique utile lors d'arthrite infectieuse.

Infectious arthritis in swine is an important cause of lameness in growing pigs.[1] Infectious lameness diagnosis in pigs can be difficult due to the transient nature of joint pathogens. Diagnostic investigations generally involve post-mortem samples, substantially limiting the specimens that are available to submit for testing. An ante-mortem joint fluid collection technique would offer practitioners additional flexibility to collect diagnostic samples without having to sacrifice animals. A challenge of this technique is achieving a sufficient plane of anesthesia for the procedure in the field. Although there are published recommendations for injectable anesthesia for pigs, these references typically do not state the protocol effectiveness for specific procedures, such as percutaneous joint fluid aspiration.[2-5] Additionally, to the knowledge of the authors, there are no peer-reviewed reports on the impact of ante-mortem joint fluid collection on lameness and synovial damage post-procedure.

The primary objective of this study was to compare four anesthetic protocols for ante-mortem percutaneous synovial fluid aspiration from healthy swine in field conditions. The protocols were evaluated in terms of successful anesthesia, time to recovery, and protocol cost. The secondary objective was to assess the iatrogenic impact of ante-mortem joint fluid collection by monitoring lameness and joint swelling for 7 days post treatment and assessing histology at day seven.

Materials and methods

The trial was approved through the Iowa State University Institutional Animal Care and Use Committee.

Animals, housing, feed, and water

Prior to the initiation of the trial, pigs were housed in pens with partially slatted flooring in groups of 15 to 20 in a feeder-to-finisher barn with a total group size of approximately 200. At selection for the trial, 80- to 90-kg pigs were moved from group housing to individual pens for the procedures described below. Pigs were first assessed while standing and observed while walking to ensure they did not display lameness or swollen joints. Pigs were given a physical exam by a veterinarian, which included joint palpation, and only pigs free of clinical signs of illness, such as coughing, diarrhea, and lameness, were included in the trial.

All pigs were provided ad libitum access to a commercial finisher feed without antibiotics for the duration of the trial and had ad libitum access to water. The diets met the National Research Council requirements for swine.[6] Neither feed nor water was withheld from pigs prior to anesthesia.

Treatment allocation

There were 24 pigs in this trial and the group was a mix of barrows and gilts. After selection, pigs were weighed, ear-tagged, and each was randomly allocated, using a random number table, to one of four anesthetic protocols: telazol-ketamine-xylazine (TKX); telazol-ketamine-acepromazine(TKA); telazol-acepromazine with lidocaine epidural (TAL); or ketamine-acepromazine with lidocaine epidural (KAL). Generally, for each protocol, an initial minimum dose was given and then additional step-dosing was done until anesthesia was sufficient for the procedure or until the a priori maximum dose was achieved within 1.5 hours of the initial dose. If the maximum dose was achieved and an insufficient plane of anesthesia was attained for joint fluid collection, the pig was not given any more anesthetic agents and was monitored until recovery. Pigs receiving the TKX treatment were given an initial intramuscular (IM) injection of 4.4 mg/kg telazol (tiletamine HCl and zolazepam HCl injection; Zoetis, Kalamazoo, Michigan), 2.2 mg/kg ketamine (Zoetis) and 4.4 mg/kg xylazine (VetOne, Boise, Idaho) combined

in the same syringe[3,5] with a maximum cumulative dose of 4.4 mg/kg of ketamine and 8.8 mg/kg each of xylazine and telazol.

Pigs receiving the TKA treatment were given an initial IM injection of 0.03 mg/kg acepromazine (VetOne, Boise, Idaho), 2.2 mg/kg of ketamine, and 4.4 mg/kg telazol combined in the same syringe[3] with a maximum cumulative dose of 10 mg/kg telazol, 0.07 mg/kg acepromazine, and 5 mg/kg of ketamine.

Pigs receiving the TAL treatment were given an initial IM injection of 0.3 mg/kg acepromazine and 4.4 mg/kg telazol in the same syringe[2,3] with a maximum of 0.5 mg/kg acepromazine and 11 mg/kg telazol until the pig was in a suitable anesthetic plane to administer a lumbosacral epidural. The lumbosacral epidural consisted of 2% lidocaine (MWI, Boise, Idaho) dosed at 2.2 mg/kg, up to a maximum of 10 mL/pig.

Pigs receiving the KAL treatment were given an initial IM injection of 0.5 mg/kg acepromazine and 5 mg/kg ketamine mixed in the same syringe[3,4] with a maximum 1.2 mg/kg acepromazine and 33 mg/kg ketamine until a suitable anesthetic plane was achieved to administer epidural anesthesia.[2,7] The lumbosacral epidural consisted of 2% lidocaine dosed at 2.2 mg/kg, up to a maximum of 10 mL/pig.

Between 5 and 10 minutes after the initial IM injection, pigs were assessed for sedation depth, which was based on their behavior and reflex responses. To be considered eligible for the joint fluid collection procedure (sufficient anesthesia), the pig must have been recumbent, with a negative palpebral response and negative toe withdrawal response. If these criteria were not met or the pig reacted to the needle insertion in the joint, then an additional dose of the applicable treatment protocol was administered. At this time, if the pig was recumbent and unconscious, then the second dose of the anesthetic combination given was half of the initial doses described above. However, if the pig was conscious and ambulatory after the initial dose, the full initial dose was repeated. The animal was then left alone with minimal background noise and was reassessed 5 to 15 minutes later. This process was repeated until a suitable depth was attained or the maximum dose was administered. Under these dosing parameters, a pig could be re-dosed without reaching the maximum dose limit.

Placement of epidural

For the TAL and KAL treatment groups, a lumbosacral epidural was placed using an 18G by 8.9-cm spinal needle (BD, Franklin Lakes, New Jersey) as previously described.[3,8,9] Briefly, a 25 cm × 25 cm section on midline at the cranial aspect of the tuber coxae was shaved and aseptically prepared for the epidural. After shaving, the surgical preparation consisted of three steps: a chlorhexidine soap scrub, an alcohol scrub, and a final surgical preparation with tincture of chlorhexidine. Steps one and two were repeated three times. To administer the epidural, a veterinarian wore sterile gloves and inserted the epidural needle into the intervertebral disc space between lumbar vertebra six and sacral vertebra one. Lidocaine was injected into the spinal canal as previously reported.[3,8,9]

Synovial fluid collection

Under anesthesia, pigs were positioned in dorsal recumbency. One tarsus (all groups) and one carpus (TKX and TKA treatment groups only) were selected for sampling. An aseptic preparation, as previously described for epidural injection, was performed on the joints prior to sampling. Sterile 18G by 3.8-cm needles (Monoject BD Bioscience, San Jose, California) with 12-mL syringes (Monoject BD Bioscience) were used for the joint fluid aspirations. Sterile gloves and coveralls were worn.

If a needle was inserted into the joint, whether or not fluid was successfully collected, it was recorded and that joint subsequently monitored.

Anesthesia monitoring

From the initial IM injection onwards, pigs were monitored closely until recovery. Heart rate, respiratory rate, rectal temperature, and depth of sedation were monitored at least every 15 minutes until the joint aspiration was performed, then monitoring changed to every 30 minutes. Heart rate was assessed using thoracic auscultation and respiration rate was counted by observing the rib cage expansion and contraction. Rectal temperature was measured with a digital thermometer. Once the pig was in sternal recumbency, vital parameters were recorded hourly and the pig was assessed visually approximately every 30 minutes until it was ambulatory.

During the anesthesia and recovery process, the following data points were recorded: if sufficient plane was achieved for joint fluid aspiration (yes or no), time to joint sampling from first anesthesia injection, and time to sternal recumbency and ambulation for pigs that reached a sufficient anesthesia plane for sampling. Once pigs were fully recovered from anesthesia, the pigs were returned to their original group pens.

Post-procedure observation procedures

After pigs recovered and were ambulatory, they were scored for lameness and joint swelling. On days two, four, and seven post joint aspiration, pigs were re-assessed for lameness and joint swelling.

Lameness scoring. The gait scoring scale used was from a previously published scoring rubric.[10] Pigs were given a lameness score from zero to 5 and pigs were evaluated while standing and then while ambulating only. The modification in the scoring system used was that pigs were not evaluated with respect to response to human presence, opening of gate, or interactions with pen mates.

Joint enlargement and swelling scoring. Joint swelling scoring was performed as previously described: score 0 was no or slight joint swelling; score 1 was soft, non-warm swelling of the joint; score 2 was marked soft, fluctuating enlargement of the joint and surroundings; and score 3 was a firm and warm periarticular swelling.[11] Pigs were assessed visually and joints were palpated before assigning a score. The same individuals performed the joint and lameness scoring for all days of the trial and these individuals were not blinded to treatment allocation.

Necropsy and sample collection. Seven days after the joint fluid collection all animals were humanely euthanized for necropsy using penetrating captive bolt and exsanguination. At necropsy, all carpus and tarsus joints in which a needle had penetrated were examined. The articular cartilage, synovial fluid, and synovial tissue were assessed grossly, with abnormalities documented. Additional synovial tissue from each joint was collected and placed in 10% buffered formalin for histological evaluation. A systematic evaluation of the internal organs and other appendicular joints was performed.

Synovial tissue scoring. A board-certified veterinary pathologist who was blinded to treatment allocation conducted the synovial tissue sample evaluation using a scoring rubric modified from Hagedorn-Olsen et al[12] and published in Gomes-Neto et al.[13] The score for each category was summed to create a composite score ranging from 0 to 15. The scoring rubric encompassed two categories: first, categories that indicate active infectious processes such as neutrophils, fibrin, and hemorrhage were scored, and second, categories such as synovial proliferation or

alterations, which encompassed noninfectious and chronic joint changes were scored.

Statistical analysis

Descriptive statistics were prepared using SAS Version 9.1 (SAS Institute, Cary, North Carolina).

Results

Anesthesia protocols

In Table 1, an anesthetic protocol comparison is presented in terms of successfully producing anesthesia to allow for joint aspiration, anesthetic protocol costs, and recovery time. All treatment groups contained at least two pigs that required additional dosing beyond the initial dose. All pigs in the TKX and TAL treatment groups reached a sufficient anesthesia plane to allow joint aspiration. The recovery time for all protocols was over 3 hours. For the KAL treatment group, the first three pigs anesthetized received the maximum IM dose without reaching a sufficient anesthetic plane to place an epidural or conduct a joint aspiration. As such, the authors opted to remove the remaining three pigs from the KAL group in lieu of dosing them.

In the TKA treatment group, pig 185 died after reaching sternal recumbency and attempting to stand during the recovery process. Post-mortem evaluation revealed pulmonary congestion affecting both lungs and grossly enlarged heart with ventricular dilation. During the monitoring process, pig 185 had a numerically greater heart rate and respiration rate than its cohorts (Table 2).

The heart rate, respiratory rate, and rectal temperature of the pigs were measured regularly until the pigs were able to stand and the mean and range of each parameter is presented in Table 2. Several pigs required rewarming with blankets as their rectal temperature fell below 37°C.

Lameness and joint swelling

All pigs had a lameness score of 0 on days 0, 2, 4, and 7. One pig from the TKX treatment group had mild joint swelling (score 1) on the right carpus on day 4, which had been sampled on day 0. This swelling decreased to score 0 by day 7. A second pig from the same group had a score 1 on day 2 on the left tarsus, which was sampled previously. The score decreased to 0 on days 4 and 7 during the monitoring period. All other pigs received a joint swelling score of zero on both joints for the duration of the 7-day monitoring period.

Synovial histology

The synovium histology scoring indicated that all joints received a score of zero on all three categories related to acute inflammation: neutrophils, fibrin, and hemorrhage. The synovial fluid and synovium from these joints were grossly within expected values for a normal joint. There were four tarsus joints, two from the TKX and two from the TAL treatment groups, in which there were mild, non-specific changes to the synovium suggestive of a chronic, non-infectious process in the joint. Their cumulative synovium score ranged between 3 to 6 out of a maximum possible score of 15.

Discussion

Telazol, ketamine, and xylazine was the only treatment protocol that was consistently suitable for collection of joint fluid from market-sized pigs. The anesthesia depth produced by the other protocols was insufficient to inhibit the foot withdrawal reflex, facilitate epidural placement, or, in some cases,

Table 1: Comparison of four anesthetic protocols with respect to cost, procedure success, and recovery times in 80- to 90-kg grow-finish swine

Group information for all pigs	TKX	KAL	TAL	TKA
No. of pigs	6	3*	6	6
Mean BW (SD), kg	83.1 (12.7)	92.1 (2.7)	82.2 (6.4)	90.1 (10.7)
No. of animals for which sufficient surgical plane was achieved to allow for joint aspiration (%)	6 (100)	1 (33)†	6 (100)	2 (33)†
No. of pigs requiring at least one additional dose (%)	2 (33)	3 (100)	3 (50)	6 (100)
No. of pigs that reached maximum dosage (%)	0 (0)	3 (100)	0 (0)	2 (33)
Mean cost of anesthesia protocol (SD), USD	24.98 (4.16)	22.37 (0.82)	38.96 (4.65)	50.99 (3.65)
Procedure and recovery time for pigs that reached sufficient surgical plane for joint aspiration				
Mean time to joint aspiration from first injection in minutes (SD)‡	13 (9)	74 (NA§)	40 (7)	82 (2)
Mean time to sternal recumbency in minutes (SD)‡	125 (26)	151 (NA§)	198 (28)	363 (258)
Mean time to ambulatory in minutes (SD)‡	266 (73)	317 (NA§)	378 (79)	267¶

* As the first three pigs anesthetized did not reach a sufficient plane to place an epidural or conduct joint aspiration, the remaining three pigs in the group were not dosed and were removed from the study.
† In one pig, the joint was sampled but fluid was not collected.
‡ For pigs that reached sufficient surgical plane for sampling.
§ In the KAL treatment group, there was only one pig that appeared to reach sufficient anesthetic plane for joint aspiration, thus a standard deviation could not be calculated for the recovery time measurements.
¶ One pig died after achieving sternal recumbency.
TKX= telazol, ketamine, and xylazine; KAL= ketamine and acepromazine with lidocaine epidural; TAL= telazol and acepromazine with lidocaine epidural; TKA= telazol, ketamine, and acepromazine; BW = body weight; SD = standard deviation; NA = not applicable.

Table 2: Mean, minimum, and maximum heart rate, respiratory rate, and rectal temperature of 80- to 90-kg grow-finish pigs each treated with one of four injectable anesthetic protocols*

Pig no.	Heart rate (beats/min)			Respiratory rate (breaths/min)			Rectal temperature (°C)		
	Mean	Low	High	Mean	Low	High	Mean	Low	High
TKX treatment									
178	116	104	140	34	28	44	38.9	38.0	39.9
179	98	88	128	43	24	60	38.7	37.8	39.5
180	111	90	140	39	28	52	39.1	38.5	39.7
181	101	80	120	38	24	52	38.1	37.3	38.9
182	96	84	112	41	20	76	38.2	37.5	39.6
183	82	64	100	50	32	80	37.7	36.7	38.6
KAL treatment									
190	115	68	148	35	24	48	38.2	37.6	39.0
191	117	72	148	45	44	48	37.3	36.6	38.3
192	89	52	128	34	28	44	37.4	36.4	38.4
TAL treatment									
193	121	96	160	40	28	52	36.7	35.9	38.9
194	109	64	140	41	28	64	37.9	36.7	39.6
195	119	104	132	44	24	76	37.3	36.6	39.2
196	108	72	120	34	20	48	36.6	36.0	37.7
197	122	72	160	57	40	80	37.8	36.2	39.4
198	90	72	108	37	28	60	36.7	35.2	38.8
TKA treatment									
184	105	56	128	30	28	40	37.9	36.8	39.0
185†	160	120	200	55	36	84	38.2	37.0	39.3
186	122	60	160	39	24	60	38.2	37.5	39.1
187	96	78	116	53	36	78	38.0	36.6	39.6
188	100	80	140	29	18	44	38.2	37.4	39.5
189	100	80	120	42	36	44	37.3	36.5	38.5

* Each parameter was measured until pigs were able to stand.
† Pig number 185 died before it was observed to have stood.
TKX = telazol, ketamine, and xylazine; KAL = ketamine and acepromazine with lidocaine epidural; TAL= telazol and acepromazine with lidocaine epidural; TKA = telazol, ketamine, and acepromazine; min = minute.

achieve unconsciousness. None of the pigs in this study were lame post procedure, nor was there iatrogenic infectious arthritis evidence identified in any treatment pigs.

There are several resources available to practitioners that recommend drug combinations, drug dosages, and practical tips for in-field anesthesia.[2-5,7,14] These resources provide general descriptions for the duration of effect, contraindications, adverse effects, and pharmacology. Absent from these resources is an evaluation of the utility for a particular protocol and procedure in a specific age of pig. Without this information, there is increased reliance on practical experience in lieu of evidence-based medicine for anesthetic protocol selection for use in field situations and settings.

Additional considerations for field applications of the TKX protocol are that the duration of xylazine is relatively short (10 to 30 minutes) and xylazine's analgesic, sedative, and muscle relaxation effects are critical to balance the muscle spasticity and rigidity associated with ketamine in combination protocols.[3,8,15,16] Thus, there is a short window for optimal joint aspiration procedure using the TKX protocol, and the practitioner needs to monitor the animal closely so as to not inadvertently miss this window and require re-dosing, particularly if sampling more than one pig simultaneously. Performing a foot withdrawal test using a needle is an easy and non-invasive method to assess the withdrawal reflex and suitability for joint aspiration.

During substantial recovery times as observed in this study, the potential exists for physiological complications which neccesitates active monitoring and veterinary management. Recovery time typically decreases in smaller (young) pigs due to different body composition and metabolism rate. For ex-

ample, in two studies on telazol and xylazine in 37-kg crossbred pigs using similar parameters to this study, the pigs reached sternal recumbency in 76 to 98 minutes and were standing at 100 to 130 minutes post initial injection.[14,17] However, these studies did not use ketamine with telazol and xylazine, thus direct recovery time comparisons cannot be made to the recovery times published in the present study.

Epidural placement was successful in the pigs in the TAL treatment group but required additional equipment and technical skill beyond the joint aspiration. Compared to the TKX treatment group, there was a great delay between initial IM injection and joint fluid collection and ultimately, recovery. Despite this, epidurals in swine may be useful for other procedures such as scrotal and inguinal hernia repair.[18]

From the post-mortem findings and elevated vital parameters while under anesthesia, it is believed that pig 185 experienced cardiac or respiratory complications that lead to its death. In this study and in the field setting, it would be difficult to screen pigs for pre-existing conditions beyond a visual examination and thoracic auscultation. Since pigs have a relatively small lung capacity compared to horses and companion animals, knowledge of pre-existing conditions, such as previous bouts of pneumonia, would be important when selecting good candidates for anesthesia and subsequent ante-mortem joint aspirations.[8] Additionally, pig 185 was in the TKA treatment group which received a larger dose of acepromazine than other groups. Acepromazine is known for its hypotensive effects that may have negatively affected cardiac output in this pig.[19] For this reason, in addition to recovery time, it is not advised that practitioners use TKA in the field for market weight hogs.

The mean values for individual pig heart rate, respiratory rate, and temperature were generally elevated compared to normal values for finisher pigs reported in Anderson and St Jean.[3] As well, within each of the treatment groups, there was variability in vital parameters between individual pigs, at least under the conditions presented in the current study. For example, mean heart rate in the TKX treatment group ranged between 82 and 116. Information about normal vital parameters for commercial pigs in field conditions is limited. Published values for vital parameter information under specific anesthetic regimes in the field are not available. Thus, Table 2 provides information for practitioners on the vital parameter values and variability they may encounter while performing field anesthesia in finisher pigs.

This report emphasizes the use of tools readily available to practitioners in the field to monitor vital parameters. This is unique from other anesthetic evaluation and comparison studies in which there is additional monitoring performed including blood pressure, arterial blood gases, and blood biochemistry.[14,17,20] In those studies, expanded monitoring was critical to collect the data required to compare the physiological effects when different protocols are utilized which served as the primary objective of the research. The present study focused on the ability of anesthetic protocols to provide appropriate conditions for efficacious completion of a diagnostic task.

The TKX protocol performed well during this ante-mortem procedure and allowed for successful joint fluid collection and prompt recovery post procedure. An anesthetic protocol for ante-mortem joint aspiration that is applicable to commercial settings and cost effective is a valuable tool to practitioners for diagnostic lameness investigations. The ante-mortem technique allows practitioners to increase their diagnostic sample size, and monitor treatment success in sampled pigs, and can complement post-mortem examinations in affected herds. Veterinary practitioners must carefully consider the local, state, and federal regulatory consequences and current rules or guidance before utilizing any anesthetic protocol in the field. Guidelines for extra-label use of medications in animals and guidance specific to the use of anesthetic agents in food animals are available from the Federal Drug Administration (United States) and Health Canada (Canada). Additionally there are online food animal database avoidance services in the United States (`http://www.farad.org`) and Canada (`https://cgfarad.usask.ca/`) which fulfill withdrawal time requests from practitioners for individual cases and specific drug regimens.

Implications

- The TKX treatment was the best overall anesthetic protocol for ante-mortem joint fluid collection in this trial. Based on the findings from this trial, with a limited sample size, these dosing guidelines worked well to facilitate successful joint fluid collection: an initial IM injection of 4.4 mg/kg telazol (tiletamine HCl and zolazepam HCl injection), 2.2 mg/kg ketamine, and 4.4 mg/kg xylazine combined in the same syringe with a maximum cumulative dose of 4.4 mg/kg of ketamine and 8.8 mg/kg each of xylazine and telazol. If the pig is recumbent and unconscious after the initial dose of TKX but still has a palpebral or toe withdrawal response, an additional dose of half of the initial dose worked well in this trial to attain the sufficient depth.
- Veterinary practitioners must consider the local, state and federal regulatory consequences and current rules or guidance before utilizing any anesthetic protocol in the field.
- Ante-mortem joint fluid collection was not associated with significant joint tissue damage and is therefore potentially a useful diagnostic tool for infectious arthritis in pigs.

Acknowledgments

Thank you to Iowa State University Swine Nutrition Farm staff for their assistance, especially Trey Faaborg and Tim Hicks. Thank you to the Swine Medicine Education Center (SMEC) summer interns, Megan Nickel and Rochelle Warner, for their help with the live animal work. We sincerely appreciate the efforts of SMEC veterinarians Justin Brown and Anna Forseth who were instrumental in monitoring the animals. National Pork Board, Iowa Pork Producers Association and PIC provided funding for this project.

Conflict of interest

None reported.

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*Non-refereed reference.

Conversion tables

Weights and measures conversions

Common (US)	Metric	To convert	Multiply by
1 oz	28.35 g	oz to g	28.4
1 lb (16 oz)	453.59 g	lb to kg	0.45
2.2 lb	1 kg	kg to lb	2.2
1 in	2.54 cm	in to cm	2.54
0.39 in	1 cm	cm to in	0.39
1 ft (12 in)	0.31 m	ft to m	0.3
3.28 ft	1 m	m to ft	3.28
1 mi	1.6 km	mi to km	1.6
0.62 mi	1 km	km to mi	0.62
1 in^2	6.45 cm^2	in^2 to cm^2	6.45
0.16 in^2	1 cm^2	cm^2 to in^2	0.16
1 ft^2	0.09 m^2	ft^2 to m^2	0.09
10.76 ft^2	1 m^2	m^2 to ft^2	10.8
1 ft^3	0.03 m^3	ft^3 to m^3	0.03
35.3 ft^3	1 m^3	m^3 to ft^3	35
1 gal (128 fl oz)	3.8 L	gal to L	3.8
0.264 gal	1 L	L to gal	0.26
1 qt (32 fl oz)	946.36 mL	qt to L	0.95
33.815 fl oz	1 L	L to qt	1.1

Temperature equivalents (approx)

°F	°C
32	0
50	10
60	15.5
61	16
65	18.3
70	21.1
75	23.8
80	26.6
82	28
85	29.4
90	32.2
102	38.8
103	39.4
104	40.0
105	40.5
106	41.1
212	100

°F = (°C × 9/5) + 32
°C = (°F - 32) × 5/9

Conversion chart, kg to lb (approx)

Pig size	Lb	Kg
Birth	3.3-4.4	1.5-2.0
Weaning	7.7	3.5
	11	5
	22	10
Nursery	33	15
	44	20
	55	25
	66	30
Grower	99	45
	110	50
	132	60
Finisher	198	90
	220	100
	231	105
	242	110
	253	115
Sow	300	135
	661	300
Boar	794	360
	800	363

1 tonne = 1000 kg
1 ppm = 0.0001% = 1 mg/kg = 1 g/tonne
1 ppm = 1 mg/L