

JOINT TRAUMA SYSTEM K9 CLINICAL PRACTICE GUIDELINE



Diagnostic Imaging (K9 CPG:20)

This CPG provides operational guidance for the use of diagnostic imaging in the evaluation of injured Military Working Dogs (MWDs).

CONTRIBUTORS

MAJ Kerri Haider, VC, USA
MAJ Katherine McDonald, VC, USA

LTC Erin Mays, VC, USAR
MAJ Erin Hennessey, VC, USAR

Previous contributors: LTC (Ret) Michael Lagutchik, VC, USA; LTC Janice Baker, VC, USAR; MAJ Jamie Brown, VC, USA; COL (Ret) Walter Burghardt, BSC, USAF; LTC(P) Matthew Enroth, VC, USA; LTC Shannon Flournoy, VC, USA; LTC (Ret) James Giles, III, VC, USA; MAJ Patrick Grimm, VC, USA; LTC Jennifer Hiniker, VC, USA; COL Jacob Johnson, VC, USAR; COL (Ret) Kelly Mann, VC, USA; MAJ (Ret) Eric Storey, VC, USAR; LTC Matt Takara, VC, USA; MAJ (Ret) Todd Thomas, VC, USA; LT Cory Frappier, MC, USN

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SUMMARY OF CHANGES

1. Added background information and information about operational imaging capability by roles of care.
2. Added information about radiographs and point of care ultrasound (POCUS) examinations.
3. Updated magnetic resonance imaging (MRI) information, recommending that MRI be a secondary diagnostic tool in an operational environment after computed tomography (CT), and removed specific sequence recommendations.
4. Added information about specialized imaging techniques (retrograde urethrogram and CT cystography).
5. Added appendices that include detector CT protocols.

BACKGROUND

Medical imaging is a critical component of trauma evaluation in modern military medical systems. Imaging provides rapid identification of life-threatening injuries, allows prioritization of surgical interventions, and facilitates triage decisions during evacuation across the continuum of care. In deployed environments, the ability to obtain timely diagnostic imaging may directly influence survival, particularly in patients with occult thoracic or abdominal injuries that may not be apparent on initial clinical examination.¹⁻³

Military Working Dogs are routinely exposed to operational hazards like those encountered by deployed personnel. These hazards include blast exposure, high-velocity ballistic trauma, vehicular impact, crush injury, falls from height, and penetrating trauma associated with combat or training operations.⁴⁻⁶ The injury patterns produced by these mechanisms frequently involve multiple body

systems and may include thoracic trauma, intra-abdominal hemorrhage, pelvic fractures, traumatic brain injury, spinal injury, and complex extremity injuries.⁷

Clinical examination alone is frequently insufficient to exclude internal injury in trauma patients. In both human and veterinary trauma populations, the severity of internal injury correlates poorly with external signs of trauma. Patients may initially appear stable despite the presence of significant thoracic or abdominal injuries, particularly in the early stages following injury.⁸⁻¹⁰

Advances in multi-detector CT technology have significantly expanded the role of CT imaging in trauma care. Modern CT scanners allow rapid acquisition of high-resolution images of the entire body within seconds, enabling identification of injuries that may be missed by radiography or ultrasound.¹¹

Sedation or general anesthesia is typically needed for advanced imaging in MWDs to prevent motion artifact and ensure adequate image quality. MWDs have a deeper thoracic cavity and greater variation in lung inflation patterns depending on positioning compared to humans. Certain injury mechanisms, such as bite wounds or impalement injuries, occur with greater frequency in veterinary trauma populations.¹²

When veterinary personnel are not available to provide immediate care, human healthcare providers may be required to make diagnostic and therapeutic decisions for MWD care but should always consult a veterinarian as soon as possible.

MWD OPERATIONAL IMAGING CAPABILITY BY ROLE OF CARE

Role 1:

- Little or no imaging capability. Focus is to provide immediate lifesaving interventions and rapid evacuation rather than definitive diagnostic evaluation. When imaging capability exists at Role 1, it is typically limited to portable handheld ultrasound devices that can be used to perform focused point-of-care ultrasound examinations. In this environment, imaging should be used solely as a rapid triage tool and should never delay evacuation of critically injured animals to higher levels of care.

Role 2:

- Limited diagnostic imaging capability, including portable radiography units and handheld ultrasound systems. Imaging should focus on rapid identification of injuries that require immediate intervention or that may influence evacuation priorities. Radiographs obtained in this environment are frequently limited by equipment constraints, including reduced generator output and limited image penetration, which may decrease diagnostic quality when imaging larger dogs.

Role 3:

- The highest level of imaging capability available within the deployed theater. These facilities may possess full diagnostic radiography systems, dedicated ultrasound machines, and multi-detector CT scanners capable of performing whole-body trauma imaging. When available, CT imaging should be strongly considered for stable trauma patients because it provides the most comprehensive evaluation of polytrauma injuries.

RADIOGRAPHS

Portable radiography remains an important diagnostic tool in deployed environments because of its widespread availability and rapid acquisition time. Portable x-ray units are commonly available in Role 2 and Role 3 facilities and can be used to obtain thoracic, pelvic, and extremity radiographs during trauma evaluation.

Obtain thoracic radiographs in a ventrodorsal (anterior-posterior) or dorsoventral (posterior-anterior) projection, depending on MWD stability and positioning constraints. In critically ill animals, sternal recumbency may be preferable because it allows maintenance of spontaneous ventilation and minimizes respiratory compromise. Lateral radiographs may be obtained when feasible, although image quality may be limited in larger animals when using portable x-ray systems with limited generator output.

Pelvic radiographs are used to evaluate pelvic fractures, which may be associated with urogenital injury or, less commonly, significant hemorrhage. In the deployed environment, obtaining diagnostic-quality pelvic radiographs may be challenging due to positioning limitations or patient instability.

Radiographs can also be used to evaluate extremity injuries when fractures are suspected. In cases of penetrating trauma, radiographs can be useful for identifying retained metallic fragments and estimating potential injury trajectories.

Radiographs should generally be considered screening tools rather than definitive diagnostic studies when CT imaging is available. If extremity injury alone is suspected, radiographs can be obtained. These can be time-consuming and should not delay more diagnostic imaging with CT, if available.

POINT OF CARE ULTRASOUND

Point of care ultrasound in the trauma setting is frequently referred to as Focused Assessment with Sonography for Trauma (FAST). It is used as a rapid bedside method for detecting free fluid and certain life-threatening thoracic conditions. In MWD evaluation, FAST may represent the only imaging modality available at Role 1 level of care and remains an important adjunct during early trauma resuscitation at higher levels of care. It should be considered a screening tool and not a definitive diagnostic study and is most useful in MWDs that are hemodynamically unstable or when imaging resources are limited.

Veterinary FAST protocols differ slightly from human FAST examinations due to differences in anatomy and thoracic conformation. In veterinary medicine, two FAST examinations are commonly performed: Abdominal FAST (AFAST) and thoracic FAST (TFAST). These examinations are designed to rapidly detect hemoperitoneum, pleural effusion, pericardial effusion, and pneumothorax.

In veterinary trauma populations, FAST examinations have demonstrated good agreement with CT imaging for detection of free fluid, although they remain limited in their ability to identify the specific source of hemorrhage or detect injuries that do not produce fluid accumulation.¹³⁻¹⁵

AFAST

Abdominal FAST is used to detect free fluid within the abdominal cavity. The presence of free fluid following trauma is highly suggestive of internal hemorrhage, although other causes such as urinary tract rupture must also be considered.

Use a curvilinear ultrasound probe operating between 5–10MHz. A phased-array probe may also be used when necessary. Ultrasound machines used for AFAST examinations do not require advanced imaging capabilities; even handheld portable devices are generally sufficient.

Position MWDs in standing, sternal, or lateral recumbency depending on stability. Unlike human trauma imaging, dogs may tolerate examination in multiple positions without significant changes in diagnostic accuracy.

Four primary acoustic windows are evaluated during the AFAST examination (see Figure 1):

1. **Diaphragmatic-hepatic (DH) view** – This view evaluates the interface between the liver and diaphragm and allows detection of free fluid within the cranial abdomen. The probe is placed just caudal to the xiphoid process and angled cranially toward the diaphragm.
2. **Hepato-renal (HR) view** – This view evaluates the region between the liver and right kidney. The probe is placed along the right lateral abdominal wall just caudal to the costal arch.
3. **Spleno-renal (SR) view** – This view evaluates the interface between the spleen and left kidney. The probe is placed on the left lateral abdominal wall slightly caudal to the costal arch.
4. **Cysto-colic (CC) view** – This view evaluates the caudal abdomen near the urinary bladder. The probe is placed just cranial to the pubis and angled slightly cranially. Free fluid typically appears as anechoic (black) fluid pockets within dependent regions of the abdomen. In early trauma cases, only small amounts of fluid may be present, and repeated examinations may be necessary if clinical suspicion remains high.

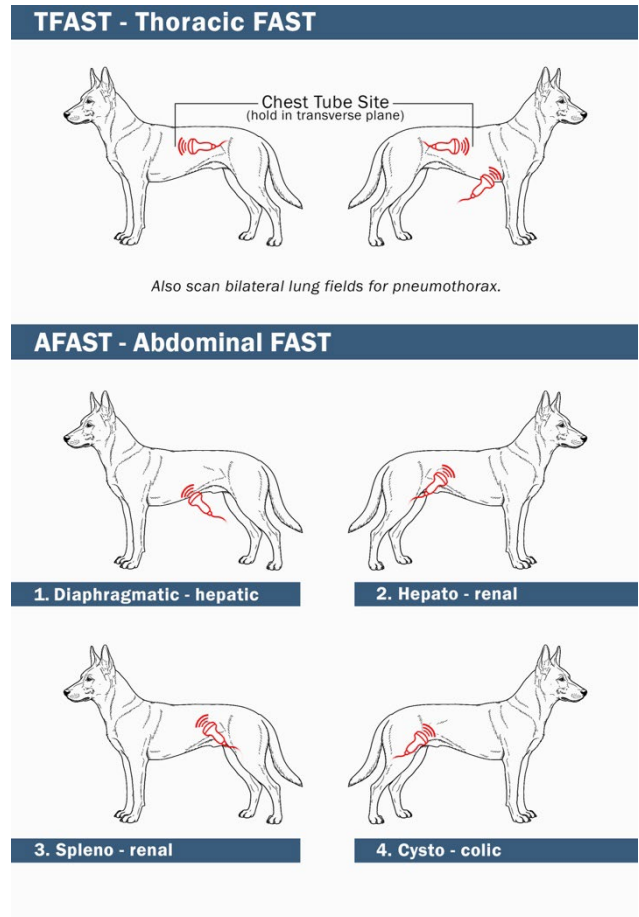


Figure 1. Canine TFAST and AFAST probe locations.

TFAST

Used to detect pleural fluid, pericardial effusion, and pneumothorax. Place MWDs in sternal recumbency, although lateral recumbency may also be used depending on stability. Place ultrasound probe along the thoracic wall at several intercostal spaces to evaluate for abnormalities (see Figure 1). Important sonographic findings include:

Pleural effusion - Pleural fluid appears as an anechoic fluid layer between the lung surface and thoracic wall. Even small volumes of fluid can be detected using ultrasound.

Pericardial effusion - Fluid surrounding the heart may indicate pericardial hemorrhage or cardiac injury. The cardiac window is typically obtained by placing the probe near the right parasternal region.

Pneumothorax - In normal lungs, the visceral and parietal pleura slide against each other during respiration, producing a characteristic “lung sliding” artifact on ultrasound. The absence of lung sliding may indicate pneumothorax. Additional signs such as the “lung point” sign may further support the diagnosis. While TFAST is highly sensitive for detection of pleural fluid, it is less reliable for detecting a small pneumothorax or pulmonary contusions. Therefore, negative findings should not exclude thoracic injury.

COMPUTED TOMOGRAPHY

Computed tomography has become the preferred imaging modality for comprehensive trauma. Compared with radiography and ultrasound, CT imaging provides superior detection of:

- Pneumothorax
- Pulmonary contusions
- Rib fractures
- Intra-abdominal hemorrhage
- Solid organ injury
- Spinal fractures
- Intracranial hemorrhage

Human trauma studies have consistently demonstrated that CT imaging identifies injuries missed by traditional imaging modalities and frequently alters management decisions.¹⁶ Similar findings have been reported in veterinary trauma populations, where CT imaging has identified clinically important injuries not detected by radiography or FAST examinations.¹³

Computed Tomography Imaging Technique

Computed tomography imaging of dogs differs from CT imaging of humans primarily because dogs cannot voluntarily remain motionless during the examination. As a result, sedation or general anesthesia (see [Analgesia and Anesthesia K9 CPG](#)) is typically required with mechanical ventilation preferred to reduce motion artifacts, which may make the study nondiagnostic. Always stabilize the MWD prior to performing CT imaging.

Military Working Dog Positioning

The standard CT trauma position for the thorax and abdomen of dogs is sternal-abdominal recumbency, with the animal positioned on its chest and the forelimbs extended forward in front of the head and hindlimbs pulled backward. The same recumbency can be used for the skull but the forelimbs are pulled caudally along the thorax. Doral recumbency is routinely used for vertebral column studies. Military Working Dogs can be entered either headfirst or hindlimb first into the gantry. Ensure the region of interest is straight and symmetrically positioned on midline of the CT table. Positioning aids such as foam wedges or sandbags may be used to stabilize the MWD and maintain proper alignment.

Contrast Administration

Intravenous (IV) iodinated contrast may be used during a CT study to enhance margins of soft tissue structures. If a CT is being conducted to assess an abnormal soft tissue mass or structure, IV iodinated contrast should be administered after acquisition of routine images. Euvolemic, euhydrated patients are the safest candidates to receive iodinated contrast. Restoration of volume should be performed prior to or in conjunction with contrast-enhanced CT protocols. Severe reactions to contrast media are rare in animals and are usually linked to ionic iodinated contrast agents. However, hypersensitivity to contrast agents can occur without prior exposure.¹⁷

The standard is non-ionic iodinated contrast media (e.g., iohexol, iopamidol). Iohexol is most commonly used in MWDs. The dose of iohexol (at 240mg/mL concentration) is 400-600mg/kg (550mg/kg preferred). The rule of thumb is 1mL of contrast agent per pound of body weight, not to exceed 60mL.

Contrast must be given IV, and the contrast is a thick, sticky solution which needs to be bolused to the MWD, so use 18-gauge catheters and needles. Contrast is most commonly given in the cephalic or saphenous vein at a rate of 1-3mL/sec. After administering the contrast bolus to the patient, only the study in the standard algorithm needs to be repeated.

Military Working Dog-Specific Protocols

Typical CT trauma imaging parameters for dogs include:

- Transverse/axial images in soft tissue and bone algorithms (+/- lung, brain) with reformats (of all transverse/axial images) in sagittal and dorsal/coronal planes. See Figure 2.
- 1.25mm slice thickness with no slide gap (0.625mm may be needed in some cases).
- Contrast requires a scan for 69 seconds and 120 seconds post injection.
- Thin-slice imaging allows reconstruction of images in multiple planes and enables creation of three-dimensional reconstructions for evaluation of complex fractures.

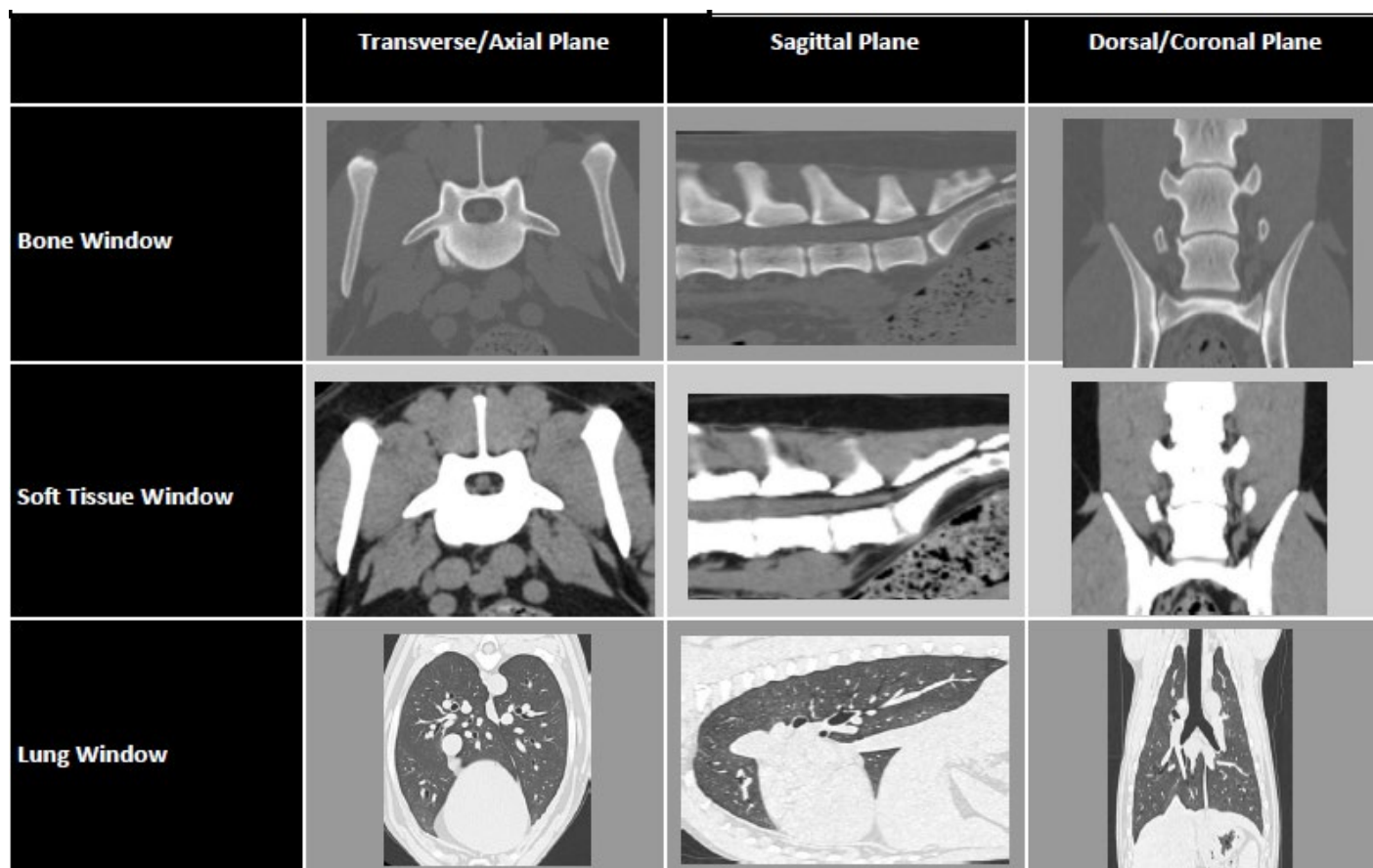


Figure 2. Canine-specific CT windows.

Computed Tomography Skull

Position in ventral recumbency (supine), with the hard palate parallel to the CT table. Studies should extend from the tip of the nose to the 2nd to 3rd cervical vertebra. Bone, standard, and bone algorithms with slice thicknesses of 2.5mm, 1.25mm, and 0.625 (if available) should be performed, respectively. Sagittal and dorsal reconstructions should be made as needed.

Computed Tomography Nasal

Position in ventral recumbency (supine), with the hard palate parallel to the CT table. Studies should extend from the tip of the nose to the larynx. A bone algorithm with slice thicknesses of 2.5mm and 0.625mm (or equivalent) and a standard algorithm with slice thickness of 1.25mm should be performed. IV contrast should be administered, and the standard algorithm with 1.25mm thick slices repeated. Dorsal reconstructions are required. Sagittal reconstructions should be made as needed.

Computed Tomography Brain

Position in ventral recumbency (supine), with the hard palate parallel to the CT table. Studies should extend from mid-muzzle to the 2nd to 3rd cervical vertebra. Bone, standard, and brain algorithms with slice thicknesses of 2.5mm, 1.25mm, and 1.25mm should be performed, respectively. Intravenous contrast should be administered and brain and standard algorithms repeated. Sagittal and dorsal reconstructions of the standard algorithms are required.

Computed Tomography Tympanic Bullae

Position in ventral recumbency (supine), with the hard palate parallel to the CT table. Studies should extend from the orbits to the 2nd or 3rd cervical vertebra. Bone and standard algorithms with slice thicknesses of 0.625 - 1.25mm and 1.25mm should be performed, respectively. Sagittal and dorsal reconstructions should be made as needed.

Computed Tomography Spine

Position in dorsal recumbency (prone), with the hind limbs maximally extended caudally (like for a hip-extended pelvic view in radiography). Study should extend through necessary vertebral regions based on pain and/or neurolocalization. More specifically for the hind limbs, if upper motor neuron (UMN) signs are present, extend from T8-T9 through sacrum, and if lower motor neuron (LMN) signs present, from T12-T13 through sacrum. CT slices should be acquired perpendicular to vertebral canal (may require gantry rotation). A bone algorithm 1.25mm slice thicknesses and a standard algorithm with 1.25mm slice thickness should be performed. For suspect lumbosacral disease, the bone algorithm of 1.25mm slice thickness should be replaced with 0.625mm (or equivalent) slice thickness to better visualize the neuroforamina at the lumbosacral junction. Sagittal and dorsal reconstructions of bone and standard algorithms are required.

Computed Tomography Thorax

Position in ventral recumbency (supine). Study should extend from thoracic inlet through caudal aspect of liver (ensure extent of all lungs imaged). Bone, standard, and lung algorithms should be performed with slice thicknesses at 5.0mm, 2.5mm, and 1.25-2.5mm, respectively. Sagittal and dorsal reconstructions of lung and standard algorithms are required.

Computed Tomography Abdomen

Position in dorsal recumbency (prone). Study should extend from caudal margin of cardiac silhouette through pelvic canal (or prostate if male). Bone and standard algorithms should be performed with slice thicknesses at 5.0mm and 2.5mm, respectively. Sagittal and dorsal reconstructions of bone and standard algorithms are required.

Computed Tomography of Extremity or Joint

Patient positioning depends on whether imaging forelimbs or hindlimbs. For forelimbs, the patient is in ventral recumbency (supine). The forelimbs should be extended cranially, resting the forearms and paws on the table with the elbows and shoulders bent at a normal resting position. If hindlimbs are the focus of the study, the patient is usually placed in dorsal recumbency (prone). The hindlimbs should be placed in maximal caudal extension, keeping both limbs symmetric and including both in the study for comparison purposes (use tape, sponges, or other positional aids). Computed Tomography slices should be acquired perpendicular to joint spaces, which may require gantry rotation if the joint is the focus of the study. Bone and standard algorithms should be performed along the affected region with slice thicknesses of 1.25mm. If a joint is the focus of the study, conducting an additional bone algorithm sequence with a slice thickness of 0.625mm is required (if available). Sagittal and dorsal reconstructions of the affected limb are required.

MAGNETIC RESONANCE IMAGING

Magnetic resonance imaging (MRI) has limited utility in the initial evaluation of trauma patients in deployed environments due to logistical constraints, prolonged acquisition times, and the requirement for general anesthesia in dogs. Magnetic resonance imaging scanners are rarely available in deployed military medical facilities, and their use in the acute trauma setting is generally impractical. In contrast, CT provides rapid acquisition of diagnostic images and remains the preferred modality for evaluation of most traumatic injuries encountered in MWDs.¹⁻³

Despite these limitations, MRI may be valuable in selected cases when available at higher levels of care or at referral veterinary facilities following evacuation. Magnetic resonance imaging provides superior soft tissue contrast compared with CT and is particularly useful for evaluation of injuries involving the central nervous system, including traumatic brain injury (TBI) and spinal cord injury.⁴

Magnetic resonance imaging may be considered when evaluating:

- Suspected spinal cord compression
- Traumatic disc herniation
- Ligamentous injury of the spine
- Intracranial hemorrhage not well characterized by CT
- Peripheral nerve injury

In most trauma scenarios, however, CT imaging provides sufficient diagnostic information to guide initial management. Magnetic resonance imaging should therefore be considered a secondary imaging modality rather than a primary trauma imaging tool.

SPECIALIZED IMAGING TECHNIQUES

Retrograde Urethrogram

When there is a clinical suspicion of possible urethral injury, which can occur with significant pelvic fractures or penetrating perineal injury, a retrograde urethrogram may be helpful to further characterize the injury. Contrast leakage outside of the urethral lumen indicates urethral disruption.

Technique

1. Insert a urinary catheter into the distal urethra.
2. Compress around the urethra to prevent backflow or *VERY SLIGHTLY* inflate the balloon only until it resists withdrawal.
3. Inject 10-15mL diluted iodinated contrast into the catheter.
4. Obtain radiographs (or CT images).

Computed Tomography Cystography

Computed tomography cystography is a reliable imaging method for evaluating suspected bladder injury in MWDs when CT imaging is available. Bladder rupture may occur following blunt abdominal trauma, pelvic fractures, blast injury (BI), or penetrating trauma. Early identification is essential because intraperitoneal bladder rupture typically requires surgical repair, whereas some extraperitoneal injuries may be managed conservatively with urinary diversion.

Routine contrast-enhanced CT of the abdomen frequently fails to adequately distend the urinary bladder and may miss bladder rupture. For this reason, retrograde contrast filling of the bladder is required when bladder injury is suspected. Computed tomography cystography has been shown to have high diagnostic sensitivity and specificity in both human and veterinary trauma populations when the bladder is adequately distended.

Technique

1. Place Foley catheter.
2. Empty bladder.
3. Dilute iodinated contrast medium to 20-50%.
4. Instill 5mL/kg diluted iodinated contrast WHILE PALPATING BLADDER to avoid over distension.
5. Clamp catheter.
6. Perform orthogonal pelvic radiographs or, ideally, pelvic CT.

PERFORMANCE IMPROVEMENT MONITORING

Population of Interest

All MWDs that received diagnostic imaging (radiographs, ultrasound, CT or MRI) in an operational environment.

Intent (Expected Outcomes)

All MWDs that sustained trauma will receive proper radiologic screening of injuries, In accordance with (IAW) availability at respective roles of care.

Performance / Adherence Measures

Determine the number of MWDs that received imaging to assist with diagnosis of injuries in an operational environment. This will include radiographs, ultrasound, CT or MRI.

- Determine the number of MWDs that received imaging at more than one role of care.
- Of these MWDs, determine if imaging performed at the higher roles of care identified injuries that were missed by imaging modalities performed at lower roles of care.

Data Source

- Patient Record
- Department of War MWD Trauma Registry
- Theater Image Repository

System Reporting and Frequency

The above constitutes the minimum criteria for Performance Improvement (PI) monitoring of this K9 CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by direction of the Committee on K9 Combat Casualty Care Chair.

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Additional Resources

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APPENDIX A: CLASS VIII MEDICAL MATERIEL

X-RAY / RADIOGRAPHY

- Portable veterinary-compatible X-ray system
- X-ray detector/cassette system
- Radiographic positioning aids
- Radiolucent positioning sponges
- Radiographic markers
- Protective lead shielding/PPE
- Radiography accessories/consumables

ULTRASOUND

- Portable diagnostic ultrasound system
- Veterinary-compatible transducers/probes
- Ultrasound gel
- Probe covers
- Ultrasound positioning aids

DIAGNOSTIC IMAGING – CT

- CT scanner/canine-compatible CT capability
- CT imaging workstation/software
- CT positioning aids, sponges, troughs and immobilization devices
- CT-compatible patient restraints/tape
- CT-compatible monitoring equipment

DIAGNOSTIC IMAGING – MRI

- MRI system with appropriate canine imaging capability
- MRI-compatible imaging coils:
 - Head/cardiac coil
 - Extremity/wrist coil
 - Appropriate body/spine coil

ANESTHESIA / SEDATION SUPPORT

- Anesthesia machine suitable for canine patients
- MRI-compatible anesthesia machine or IV anesthesia capability
- Endotracheal tubes, canine sizes
- Laryngoscope and blades
- Breathing circuits
- Anesthesia tubing/connectors
- Anesthesia filters
- IV anesthesia/sedation supplies
- Appropriate anesthetic/sedative medications

PATIENT MONITORING

- ECG monitor
- Pulse oximeter
- Non-invasive blood pressure monitor
- Doppler blood pressure unit
- Temperature monitoring equipment
- Capnography/ETCO₂ monitoring
- Anesthesia monitoring accessories/sensors

POSITIONING / IMMOBILIZATION

- Radiolucent positioning sponges
- Positioning troughs
- Foam supports
- Straps/tape for limb positioning
- Padding
- Radiolucent restraints
- Patient warming devices/blankets

DIAGNOSTIC IMAGING – MRI (CONT'D)

- MRI-compatible positioning and immobilization aids
- MRI-compatible monitoring equipment
- MRI-compatible anesthesia equipment

IV ACCESS / CONTRAST ADMINISTRATION

- IV catheters, primarily 18 gauge for CT contrast administration
- IV extension sets/T-connectors
- Syringes and needles
- IV administration sets
- IV fluids
- Nonionic iodinated CT contrast media
- Gadolinium-based MRI contrast media
- Contrast-compatible power injector/syringe system, as applicable

AIRWAY / EMERGENCY SUPPORT

- Oxygen source and delivery equipment
- Suction equipment
- Emergency airway equipment
- Ambu/resuscitation bag
- Emergency resuscitation supplies
- Crash cart/emergency medications

GENERAL IMAGING/PROCEDURE CONSUMABLES

- Alcohol/chlorhexidine skin preparation
- Sterile gloves
- Gauze
- Medical tape
- Clippers
- IV site dressings
- Syringes/needles
- Sharps containers

For additional information including National Stock Number (NSN), please contact dha.ncr.med-log.list.lpr-cps@health.mil

DISCLAIMER: *This is not an exhaustive list. These are items identified to be important for the care of combat casualties.*

APPENDIX B: MULTIDETECTOR TRAUMA CT PROTOCOLS

General Trauma Computed Tomography

1. Unenhanced spiral brain 1.25mm (bone and soft tissue algorithms); 5mm reconstructions immediately available for review.
2. Circle of Willis to pubic symphysis (bone and soft tissue algorithms).
3. 150mL biphasic contrast injection – initial 65mL at 2mL / second then 85mL at 3.5mL / second.
4. Scan starts at 60 seconds.
5. This gives both portal venous enhancement with good arterial contrast at the same time and the scan can be carried on down to the legs/feet if necessary. The cervical contrast has been very useful for penetrating injury and for spinal injury/vertebral artery injury.
6. The use of delayed scans is limited to specific cases at the request of the radiologist.

64 Detector Trauma Computed Tomography Protocol

1. Unenhanced helical brain 1.25mm (bone and soft tissue algorithms); 3mm reconstructions immediately available for review.
2. Circle of Willis to pubic symphysis 1.25mm (bone and soft tissue algorithms); 3 to 5mm reconstructions immediately available for review.
 - 150mL biphasic contrast injection – initial 80cc at 1.4cc/second then 70cc at 3.5cc/second.
 - Scan starts 3 seconds before the completion of the contrast injection.
3. This gives both portal venous enhancement with good arterial contrast at the same time and the scan can be carried on down to the legs/feet if necessary. The cervical contrast has been very useful for penetrating injury and for spinal injury/vertebral artery injury.
4. The use of delayed scans is limited to specific cases at the request of the radiologist.

16 Detector Trauma Computed Tomography Protocol

1. Unenhanced helical brain 1.25mm (bone and soft tissue algorithms); 3mm reconstructions immediately available for review.
2. Circle of Willis to pubic symphysis 1.25mm (bone and soft tissue algorithms); 5mm reconstructions immediately available for review.
 - Arterial phase imaging – 150mL single arterial phase contrast injection at 3.5cc/second.
 - Automatically triggered with a threshold of 100HU at the level of the aortic arch.
3. The arterial phase imaging alone is preferred due to the technical limitations of the scanner.
4. The use of delayed scans limited to specific cases at the request of the radiologist.

APPENDIX C: 64 DETECTOR PEDIATRIC (MWD) IV CONTROL INJECTION PROTOCOLS

WEIGHT (kg)	VENOUS PHASE RATE/VOLUME	ARTERIAL PHASE RATE/VOLUME	TOTAL CONTRAST DELIVERED
5	0.2sec/7mls	0.4sec/3mls	10
10	0.3sec/14mls	0.6sec/6mls	20
15	0.4sec/20mls	0.8sec/10mls	30
20	0.5sec/26mls	1.0sec/14mls	40
25	0.6sec/33mls	1.3sec/17mls	50
30	0.7sec/40mls	1.6sec/20mls	60
35	0.8sec/47mls	1.8sec/23mls	70
40	0.9sec/53mls	2.1sec/26mls	80
45	1.0sec/60mls	2.2/30mls	90
50	1.2sec/66mls	2.4sec/34mls	100
55	1.3sec/73mls	2.6sec/37mls	110
60	1.4sec/80mls	2.8sec/40mls	120
70	1.6sec/94mls	3.3/46mls	140
COLOR CODED PEDIATRIC DOSE SETTINGS (mA/kV)			
Pink	6.0 - 7.5 kg	59.5 - 66.5 cm	
Red	7.5 - 9.5kg	66.5 - 74 cm	
Purple	9.5 - 11.5kg	74 - 84 cm	
Yellow	11.5 - 14.5kg	84.5 - 97.5 cm	
White	14.5 - 18.5kg	97.5 - 110cm	
Blue	18.5 - 22.5kg	110 - 122cm	
Orange	22.5 - 31.5kg	122 - 137cm	
Green	31.5 - 40.5kg	137 - 150cm	
Black	40.5 - 55 kg	< 150 cm	