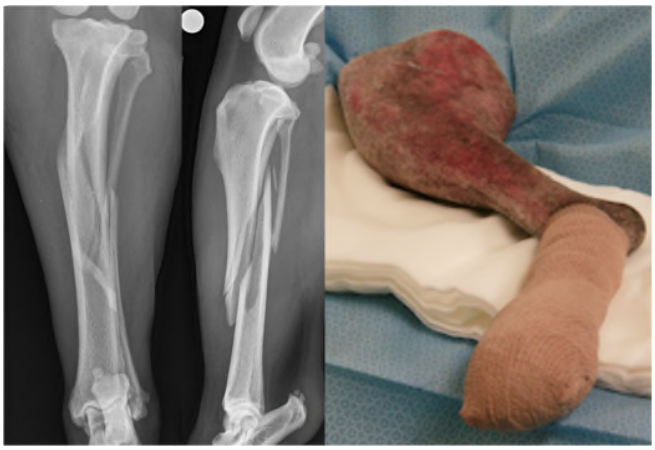
Assessment Questions AOVET Course—Advanced Course in Small Animal Fracture Management

Competency 1	Evaluate small animal patients with fractures	
Question 1	Level of difficulty: Easy	Easy (precourse)
	You are evaluating whether MIPO (minimally invasive percutaneous osteosynthesis) plate repair of this closed tibial fracture is possible. Which ONE of the following statements is correct?	
Option A	Restoration of limb length and alignment are the primary goals.	
Option B	The fracture site is directly visualised through a stab incision to allow evacuation of the fracture haematoma.	
Option C	Intra-operative fluoroscopy is essential for MIPO.	
Option D	Plate contouring is unnecessary if locking plates are used.	
Answer	A	
Rationale	With MIPO, the fracture is reduced indirectly, so the fracture site is not opened. Precise anatomical reduction is sacrificed, and bridging fixation is employed to restore the overall length and alignment of the limb. While intraoperative imaging is beneficial, MIPO techniques can be applied without intraoperative imaging for the tibia and radius. While locking plates do not need to be precisely contoured to the surface of the bone, better reduction, alignment and stability will be achieved if contouring has been performed.	
Reference	Peirone B, Rovesti GL, Baroncelli AB, Piras L. Minimally invasive plate osteosynthesis fracture reduction techniques in small animals. Veterinary Clinics of North America: Small Animal Practice. 2012 Sep 30;42(5):873-95.	

Reviewer comments, etc

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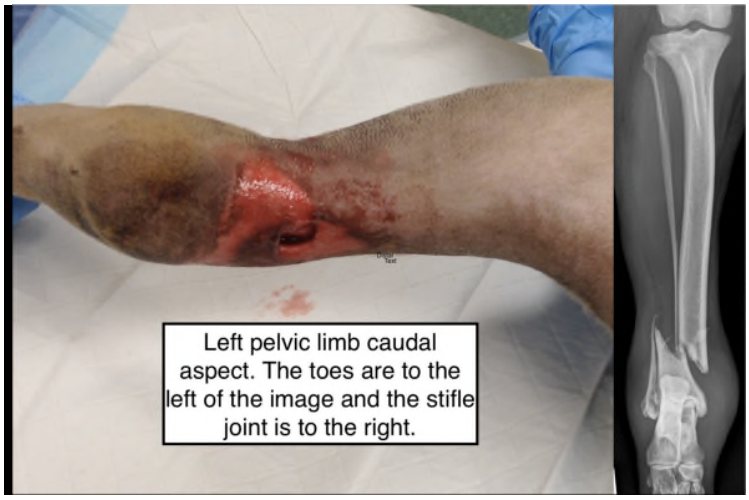
Competency 1	Evaluate small animal patients with fractures	
Question 2	Level of difficulty: Difficult	Difficult (precourse)



This is an open fracture on the caudal aspect of the distal tibia of a dog.

The full thickness skin wound is 2cm x 1cm and can be closed primarily without tension following debridement.

The surrounding inflamed skin has only superficial damage and is viable.

Which ONE of the following is correct?

Option A	This is a Type I open fracture
Option B	This is a Type II open fracture
Option C	This is a Type III open fracture
Option D	This is a Type IV open fracture
Answer	B
Rationale	This is a Type II open fracture as the soft tissue laceration is >1cm long without excessive soft tissue damage, flaps or avulsions. Type I fractures have lacerations <1cm long. Type III fractures have extensive soft tissue damage and /or comminution and cannot be primarily closed or have a traumatic amputation. There is no such thing as a Type IV open fracture.
Reference(s)	Prevention of Infection in the Treatment of One Thousand and Twenty-five Open Fractures of Long Bones: Retrospective and Prospective analyses. Gustilo, RB and Anderson, JT. JBJS Vol 58-A, 4; 453-458, 1976.

Reviewer comments, etc	
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Competency 2	Select and plan appropriate treatment options	
Question 3	Level of difficulty: Easy	Easy (precourse)
		Your colleague has asked you for advice on managing a distal radius fracture. They plan to repair this short oblique fracture with a dorsal neutralization plate protecting an independent lag screw placed from medial to lateral. Which ONE of the following is correct?

Option A	Short oblique fractures (< 30degrees to the diaphyseal axis) are not suitable for lag screw repair
Option B	The plane of this fracture is more appropriate for an independent dorsal lag screw and medially applied neutralization plate
Option C	The plane of this fracture is more appropriate for a medial neutralization plate and a dependent lag screw placed through the plate
Option D	An independent lag screw placed from medial to lateral is appropriate provided it is placed after application of a dorsal plate applied as a compression plate
Answer	A
Rationale	Short oblique fractures (< 30degrees to the diaphyseal axis) are not suitable for lag screw repair. Lag screws should be placed perpendicular to the fracture line to exert maximal interfragmentary compression. This is not possible in short oblique fractures as on tightening the screw a shear force is created across the fracture line leading to primary loss of reduction. In addition the marked eccentric loading of the screw head on the cortex is likely to cause

	iatrogenic fracture.
Reference(s)	**AO Principles of Fracture Management in the Dog and Cat**
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Competency 2	Select and plan appropriate treatment options	
Question 4	Level of difficulty: Difficult	Difficult (precourse)

A fracture of the lateral aspect of the humeral condyle was diagnosed in a 14-week-old Labrador retriever.

How should this fracture be treated?

Option A	Conservative treatment with external coaptation, to avoid placement of implants close to the distal humeral physes
Option B	Cross pin fixation, to reduce damage to the growth plates
Option C	Open reduction and internal fixation, with subsequent implant removal to allow continued growth of the humerus
Option D	Open reduction and internal fixation, with implants left in place following fracture healing
Answer	D
Rationale	As this is an articular fracture, open reduction and rigid internal fixation is indicated. Placement of implants through or across the distal humeral growth plate in a dog of this age has no impact on further growth of the humerus.
Reference(s)	Lefebvre JB[1], Robertson TR, Baines SJ, Jeffery ND, Langley-Hobbs SJ. Assessment of humeral length in dogs after repair of Salter-Harris type IV fracture of the lateral part of the humeral condyle. Vet Surg. 2008 Aug;37(6):545-51

Reviewer comments, etc	
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Competency 3	Perform operative and non-operative procedures to treat long bone fractures	
Question 5	Level of difficulty: Easy	Easy (precourse)
	Your colleague has asked you for advice on placing an intramedullary rod in a plate-rod repair of a comminuted tibial fracture. Which ONE of the following is correct?	

Option A	The intramedullary pin should be placed normograde from the proximal tibia and directed distally
Option B	The intramedullary pin should be placed retrograde from the fracture and directed proximally to exit the proximal tibia and then, following fracture reduction, be driven distally
Option C	The intramedullary pin should be placed retrograde from the fracture and directed distally to exit the medial malleolus of the distal tibia and then, following fracture reduction, be driven proximally
Option D	The intramedullary pin should be placed normograde from the medial malleolus of the distal tibia and directed proximally
Answer	A
Rationale	Intramedullary pins can be placed in the humerus, femur and tibia however are contraindicated for placement in the radius. Pins can be placed in the ulna provided the medullary canal is sufficiently wide. In the humerus and femur either normograde or retrograde placement is possible. In the tibia only normograde placement from the medial aspect of the proximal tibia is recommended to avoid damage to the cranial cruciate ligament and articular cartilage.

	Undirected retrograde placement in either a proximal or distal direction, where the pin is introduced to the medullary canal at the fracture site, will result in significant damage to either the stifle or hock joint and is contraindicated.
Reference(s)	Dixon, B.C; Tomlinson, J.L; Wagner-Mann, C.C;. Effects of Three Intramedullary Pinning Techniques on Proximal Pin Location and Articular Damage in the Canine Tibia. Veterinary Surgery, 1994, Volume 23, Issue 6

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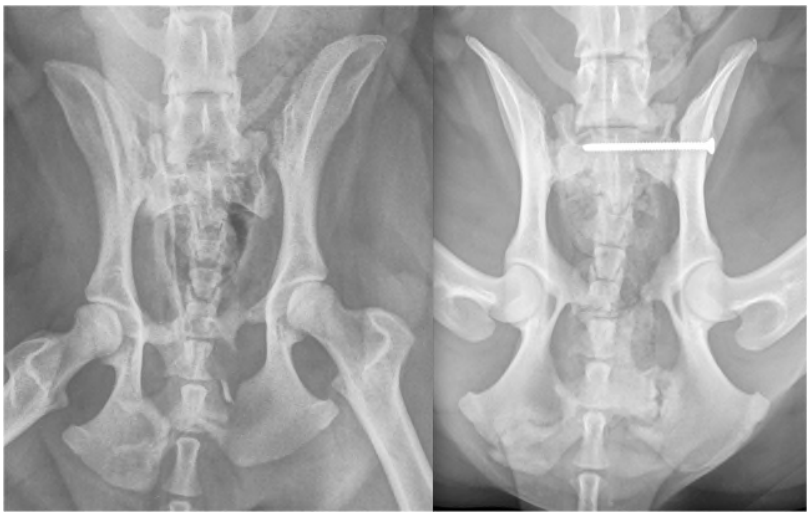
Competency 3	Perform operative and non-operative procedures to treat long bone fractures	
Question 6	Level of difficulty: Difficult	Difficult (Precourse)
	This dog had a sacroiliac (SI) screw placed to treat an unstable left SI joint. The preoperative and 10 week postoperative xrays are shown. The right SI joint was subluxated but stable. The screw engages 65% of the sacral body. Review the x rays provided and select the option that best agrees with your assessment of the engagement of the lag screw in the sacral body.	

Option A	This screw is an adequate length as it is more than 60% of the width of the sacral body.
Option B	This screw is unnecessarily long as 30-40% engagement in the sacral body has been shown to achieve sufficient stability
Option C	This screw is too long as it crosses the midline and if misdirected could penetrate the spinal canal
Option D	This screw is too short as to achieve sufficient stability in the sacrum it needs to engage the opposite ilium.
Answer	A
Rationale	In a review of 92 cases of sacroiliac luxation repairs in dogs it was found that lag screw fixation was 7 times more likely to loosen in cases where the lag screw had penetrated <60% of the sacral width compared to those where the screw had penetrated >60%. The number of screws per fixation and whether the separation was fully reduced or not did not affect whether the fixation loosened.
Reference(s)	DeCamp CE and Braden TD. Sacroiliac Fracture-Separation in the Dog. A Study of 92 Cases. Veterinary Surgery, 14, 2, 127-130, 1985

Reviewer comments, etc

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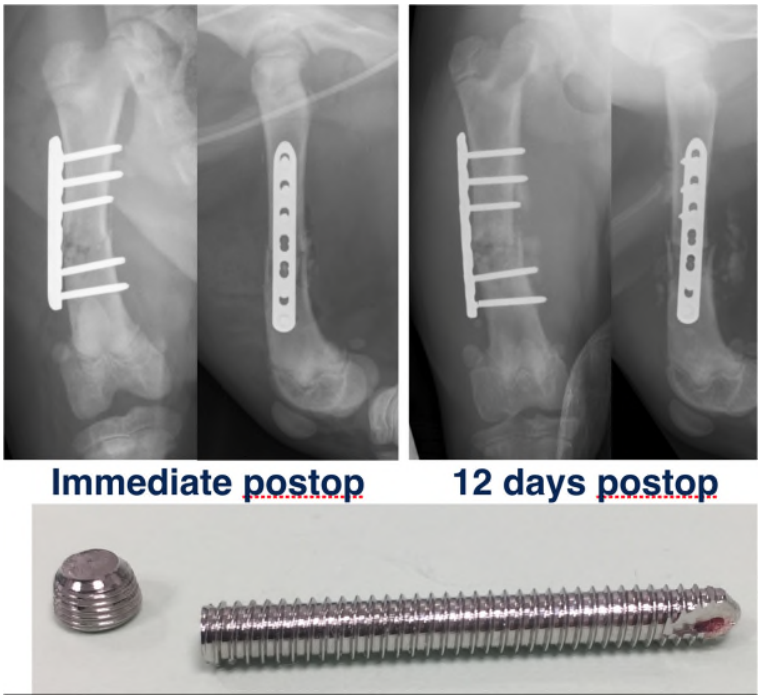
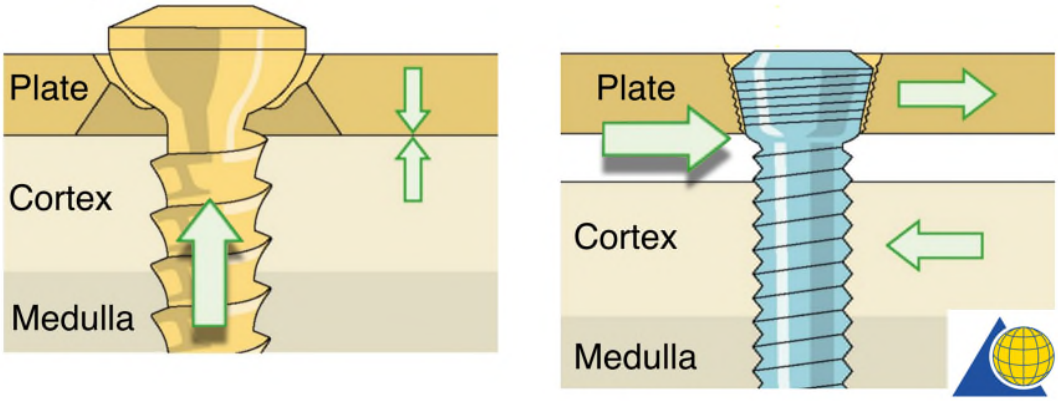
Competency 4	Formulate plans for postoperative care including recognition and management of complications	
Question 7	Level of difficulty: Easy	Precourse (easy)



These x-rays show failure of a locked screw 12 days post surgery in a 4-month-old 12 kg dog treated with a 2.7mm LCP plate applied as a bridging plate. All 5 screws are locked screws.

Which of the following statements best describes the current situation?

Option A	This is the typical mode of failure of locked screws if they have been over tightened after they are engaged in the plate.
Option B	This is the typical mode of failure of locked screws as they are loaded perpendicularly to the long axis of the screw.
Option C	This is the typical mode of failure of locked screws when they have been cross-threaded during insertion creating micro movement
Option D	This mode of failure is not typical for locked screws suggesting there may be a manufacturing fault in the screw
Answer	B
Rationale	Cortical screws and locking head screws (LHS) are loaded differently and so fail differently. The screw failure in this case is typical for LHS. LHS are subjected to mainly bending forces and shear stresses perpendicular to the

	long axis of the screw that are concentrated at the plate-screw interface / screw neck. In the left hand image below of a standard non-locked plate the direction of force is longitudinal with the screw axis, and the screw is loaded in tension. In the right hand image below physiologic loading of the bone is transmitted perpendicular to the locked screw axis creating bending force and shear stress. This is why locking screws have been designed with a wider core diameter and shallower thread depth than cortical screws so that they can better resist bending and shear. 
Reference(s)	**Wagner M and Frigg R. AO Manual of Fracture Management. Internal Fixators. Concepts and cases using LCP and LISS. 2006 AO Publishing**

Reviewer comments, etc	
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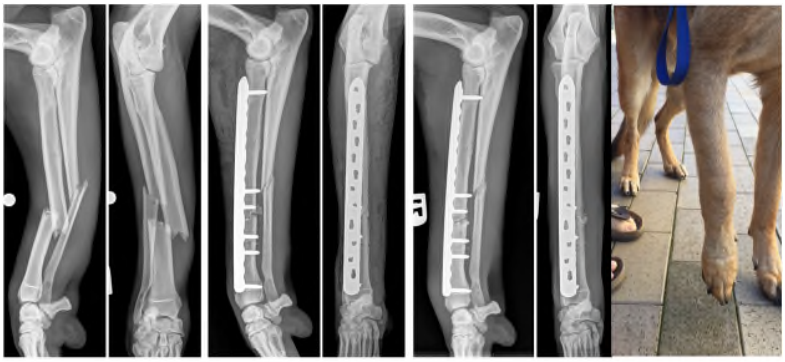
Competency 4	Formulate plans for postoperative care including recognition and management of complications	
Question 8	Level of difficulty: Difficult	Difficult (precourse)



Pre op Immediate post op 3 weeks post op

This dog has become non-weight bearing 3 weeks after plate repair of a right antebrachial fracture.
48 hours ago he was not lame. The operated leg is hot and swollen and there is a small amount of serous discharge from the distal end of the surgical wound.
x-rays show no change in the implants or bone.

Which ONE of the following treatment options is the most appropriate course of action?

Option A	Dispense 8 weeks of broad spectrum antibiotics
Option B	Obtain a sample of the discharge and submit this for culture and decide ongoing antibiotics on the culture and sensitivity result
Option C	Obtain a deep soft tissue sample from adjacent to the fracture, submit this for culture, begin empirical antibiotic treatment and adjust antibiotic therapy based on the culture and sensitivity result
Option D	Remove the plate and screws and submit these for bacterial culture. Replace the plate with a external fixator
Answer	C
Rationale	The implants and the bone are unchanged on x-ray, indicating the fixation is still stable and competent. Infected bone will heal if the fixation is stable and the infection can be controlled so there is no immediate indication to remove the plate and screws. Confirmation of infection, identification of the bacteria and most appropriate antibiotic are necessary as a prolonged course of the correct antibiotic is essential. Not using a sensitive antibiotic will not control the infection and is very costly. Surgically obtaining a sample of tissue from the fracture site is most likely to provide the correct information. A deep tissue aspirate from adjacent to the implant could be considered and might give a positive culture.

	Culture of discharging fluid is not recommended as it usually only grows secondary skin commensals and may identify an antibiotic that is not effective against the primary infection. Removing the plate and screws at this time is contraindicated as they are still stable. Removal of the implants once healing is complete is recommended, as bacterial colonisation of the implants is likely. Placement of an ESF to achieve effective stability is unnecessary and will involve placing implants within the infected area.
Reference(s)	May, C. Management of bacterial osteomyelitis in dogs and cats. In Practice, Volume 24, Issue 6. 2002 Slunsky, P; Brunnberg, M; Brunnberg, L; Pagel, T. Post-Traumatic Osteomyelitis in Dogs and Cats and the Comparison with the Incidence of Bacterial Colonisation in Removed Plate Implants. International Journal of Applied Research in Veterinary Medicine. Volume 15, Issue 1. 2017

Reviewer comments, etc	
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Competency 5	Critically assess patient outcomes	
Question 9	Level of difficulty: Easy	easy (postcourse)
	A short oblique fracture of the distal femoral diaphysis in a 3-year-old cat had been treated by placement of an intramedullary pin and cerclage wire. 4 weeks following surgery, the cat was non-weight bearing lame. The intramedullary pin was removed, and x-rays obtained. Which ONE of the following treatment options is the most appropriate course of action?	

Option A	Removal and bacterial culture of the twist cerclage wires and placement of a larger intra-medullary pin and single loop cerclage wires
Option B	Removal and bacterial culture of the twist cerclage wires and placement of a bone plate
Option C	Removal and bacterial culture of the twist cerclage wires and placement of an external skeletal fixator
Option D	Removal and bacterial culture of the twist cerclage wires and placement of multiple intramedullary stack pins
Answer	B
Rationale	The fracture is unstable and the absence of callus at the fracture site is indicative of vascular damage from the cerclage wires +/- infection. The recommended treatment is removal and bacterial culture of the cerclage wire, excision of avascular tissue and rigid fixation. Bone plate fixation has the potential to neutralise all physiologic forces of weight bearing and to remain in place long enough for the prolonged healing that is likely for this nonunion. Conversion of the inactive nonunion to a

	compressible transverse fracture by en bloc excision of the fracture ends has been shown to be effective. Single or multiple intramedullary pins provide poor resistance against rotational forces and, as they rely on frictional contact with the bone, are unlikely to remain effective for the prolonged healing time that is likely. An external skeletal fixator could be considered however offers no advantages in this case over plate placement. The ESF cannot be placed closed as cerclage wire removal and debridement of the nonunion necessitate an open approach. Any ESF pins will by necessity be placed within the infected zone. The greater standoff distance of ESFs on the femur when compared to distal limb placement means that stability is relatively compromised. The duration that ESFs can be effectively maintained in place on the femur is typically less than the effective duration of a bone plate. Femoral ESFs can also be associated with significant postoperative morbidity.
Reference	Blaeser LL[1], Gallagher JG, Boudrieau RJ. Treatment of biologically inactive nonunions by a limited en bloc ostectomy and compression plate fixation: a review of 17 cases. Vet Surg. 2003 Jan-Feb;32(1):91-100.

Reviewer comments, etc	
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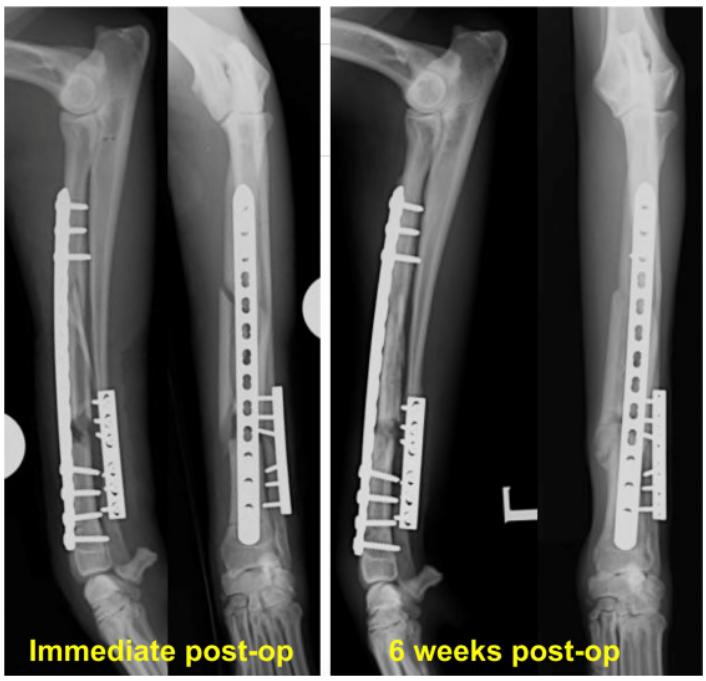
Competency 5	**Critically assess patient outcomes**	
Question 10	Level of difficulty: Difficult	Difficult (precourse)



The x-rays on the right were obtained 6 weeks following stabilization of a highly comminuted radius / ulna fracture in a 3 year old border collie. The leg is not painful to palpate.

The immediate postoperative x-rays are on the left.

Based on these 6 week follow-up x-rays what action would you take in this case?

Option A	No action is needed. Fracture healing is progressing but is not yet complete
Option B	Broad-spectrum antibiotics are indicated to treat probable osteomyelitis. Monitor x-raysically every 4 weeks
Option C	A delayed-union is present and revision surgery is indicated to obtain a deep tissue biopsy for bacterial culture and apply a cancellous bone graft
Option D	The fracture has healed and staged removal of the implants starting with the ulna plate is indicated
Answer	A
Rationale	Comminuted fractures treated by bridging fixation will heal by indirect bone healing / callus formation. The x-rays show evidence of normal indirect bone healing with widening of the fracture gap to reduce interfragmentary strain and mineralization of the callus, although this is not yet complete. There is no evidence of change in the implants and no lucency surrounding any implants. Given the radiographic evidence of bone healing and stable implants, and the absence of abnormal clinical signs further surgery or other treatment is not indicated at this stage.

Reference(s)	Pozzi A, Hudson CC, Gauthier CM, Lewis DD. Retrospective comparison of minimally invasive plate osteosynthesis and open reduction and internal fixation of radius-ulna fractures in dogs. Vet Surg. 2013 Jan;42(1):19-27

Reviewer comments, etc	
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