




## Assessment Questions AOVET Course—Principles of Small Animal Fracture Management - POSTCOURSE


Competency 1		Evaluate small animal patients with fractures	
Question 1		Level of difficulty: Easy	Easy (postcourse)
		<p>A 5-year-old 2kg toy breed dog suffered this closed fracture jumping down from the bed.</p> <p>Which ONE of the following is the best option for treatment in this case?</p>	
Option A	External coaptation with a cast		
Option B	Cross pinning with Kirschner wires		
Option C	External skeletal fixator		
Option D	Bone plate		
Answer	D		
Rationale	<p>To adequately control strain in this simple fracture the surgeon should aim for absolute stability through anatomic reduction and interfragmentary compression if possible. Plates are the best implants to achieve these goals. An external skeletal fixator (ESF) may also be used, but the rate of complications using ESF is higher than when using plates on distal antebrachial fractures.</p> <p>Reported complications associated with the use of external coaptation in toy breed fractures are as high as 83%, making this an inappropriate option for treatment.</p> <p>Cross pinning is an acceptable technique to treat Salter Harris fractures of the distal radius growth plate in immature dogs, but as this is an adult dog with closed growth</p>		

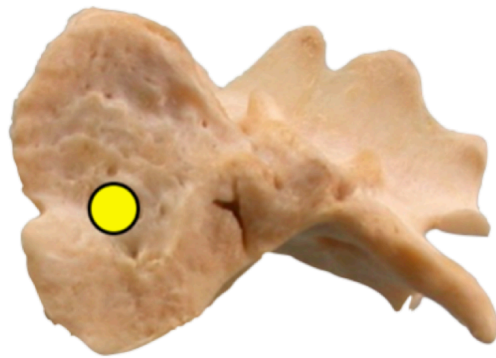
	plates the stability provided by cross pins will not be sufficient to stabilise the fracture.
<b>Reference(s)</b>	Radius and Ulna. Derek B. Fox. In Tobias KM, Johnston SA. Veterinary Surgery: Small Animal, ed 1. St Louis. 2012, chapter 55

<b>Competency 1</b>	Evaluate small animal patients with fractures	
<b>Question 2</b>	Level of difficulty: Difficult	Difficult (postcourse)
 		<p>This is type I open right femur fracture in a dog.</p> <p>The 1cm x 0.8cm skin wound is on the medial aspect of the thigh. The surrounding soft tissue is bruised but viable. There is no skin deficit and the wound can be apposed without tension.</p> <p>Which ONE of the following treatment options is the most appropriate course of action?</p>
Option A	Debridement of the open wound within 6 hours of the trauma. Management of the wound as an open wound. Treatment with intravenous antibiotics for 5-7 days to resolve infection prior to surgical stabilization.	
Option B	Debridement of the open wound within 12 hours of the trauma. Management of the wound as an open wound. Treat with intravenous antibiotics for 5-7 days to resolve infection prior to surgical stabilization.	
Option C	Surgical wound debridement and fracture repair with a plate-rod construct. Primary closure of the wound. Ongoing antibiotics determined by exit culture.	
Option D	Surgical wound debridement and fracture repair with an external skeletal fixator. Primary closure of the wound. Ongoing antibiotics determined by exit culture.	
<b>Answer</b>	C	
<b>Rationale</b>	Open fractures require surgical debridement and lavage to reduce the degree of contamination and so reduce the likelihood of subsequent infection developing.	

	<p>In the past it was thought that emergency debridement within a “golden period” was important. More recently it has been shown there is no evidence that time to debridement is associated with a higher infection rate.</p> <p>Open fractures are initially contaminated but not infected. It is the surgical debridement, lavage and stabilization that are most effective in preventing contamination developing into subsequent infection. In a human study of over 1000 open fractures, 70% had positive wound cultures on initial debridement yet only 2.5% became infected.</p> <p>As this is a Type I open fracture with no skin deficit and viable skin which can be closed without tension there is no reason not to close this wound. Following debridement, lavage and stabilization, and exit culture, primary closure of Type I and Type II fractures is usually recommended. Open wound management may be necessary in some Type III fractures.</p> <p>External skeletal fixators could be used in this case however offer no advantages over plate placement. The ESF cannot be placed closed as open fractures require debridement and lavage of the fracture to reduce the risk of infection. Any ESF pins will be placed within the contaminated zone. It is not possible to place effective implants outside of the area of contamination. The greater standoff distance of ESFs on the femur because of the large muscle mass around the bone 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 less than the effective duration of a bone plate. The high energy and open nature of this fracture means that fracture healing will be prolonged and may exceed the effective duration of an ESF. Femoral ESFs can also be associated with significant postoperative morbidity. Internal fixation of open comminuted fractures has been shown to be effective and can be placed at the time of the surgical debridement. Implant removal following fracture healing may be advised to mitigate the risk of subsequent cryptic infection.</p>
<b>Reference(s)</b>	<p>Schenker ML<sup>1</sup>, Yannascoli S, Baldwin KD, Ahn J, Mehta S. Does timing to operative debridement affect infectious complications in open long bone fractures? A systematic review. J Bone Joint Surg Am. 2012 Jun 20;94(12):1057-64</p> <p>Gustilo RB and Anderson JT. Prevention of infection in the treatment of one thousand and twenty-five open fractures of long bones. Retrospective and prospective analyses. J Bone Joint Surg. June 1976;58(4):453-458 and J Bone Joint Surg. Apr 2002; 84 (4): 682</p>



Competency 2		Select and plan appropriate treatment options	
Question 1	Level of difficulty: Easy		Easy (postcourse)
<div></div>			<p>A sacroiliac (SI) luxation in a cat has been stabilized with a sacroiliac lag screw.</p> <p>In SI luxation surgery, safe and effective screw placement is necessary for a successful outcome.</p> <p>Which ONE of the following statements about SI luxation surgery is correct?</p>
Option A	Sacroiliac screws must not extend across the midline of the sacrum to reduce the risk of inadvertently penetrating the spinal canal		
Option B	The landmark for drilling the hole in the sacrum in a cat is approximately the centre of the sacrum which is different to the dog		
Option C	The screw diameter should be 30-40% of the sacral body diameter		
Option D	Removal of the articular cartilage of the SI joint is necessary to produce effective arthrodesis		
Answer	B		
Rationale	<p>Sacroiliac screws should engage a total width of the sacral body of &gt;60% to reduce the risk of loosening. Placement across the midline is possible provided that the screw is in the sacral body and does not penetrate the spinal canal.</p> <p>In dogs the ideal position for screw placement is just caudal to a notch in the cranial border of the sacrum that is present in 99% of dogs (see left image below).</p>		



**Dog sacrum**



**Cat sacrum**

The equivalent notch is only present in 34% of cats so is not a useful anatomic landmark. The ideal location for a sacral screw in the cat has been shown to be 51% of the distance from the cranial margin of the sacral wing and 47% from the dorsal margin of the sacral wing. This is different to the location in dogs.

The diameter of the screw has not been shown to reduce the risk of screw loosening.

The SI joint is a fibrous joint and arthrodesis is not necessary for successful outcome.

**Reference(s)**

The surgical anatomy of the canine sacrum for lag screw fixation of the sacroiliac joint. DeCamp CE and Braden TD. Veterinary Surgery 14, 2, 131-134. 1985

Surgical anatomy of the feline sacroiliac joint for lag screw fixation of sacroiliac fracture-luxation. Burger, Forterre and Brunnberg. Vet Comp Orthop Traumatol 3/2004

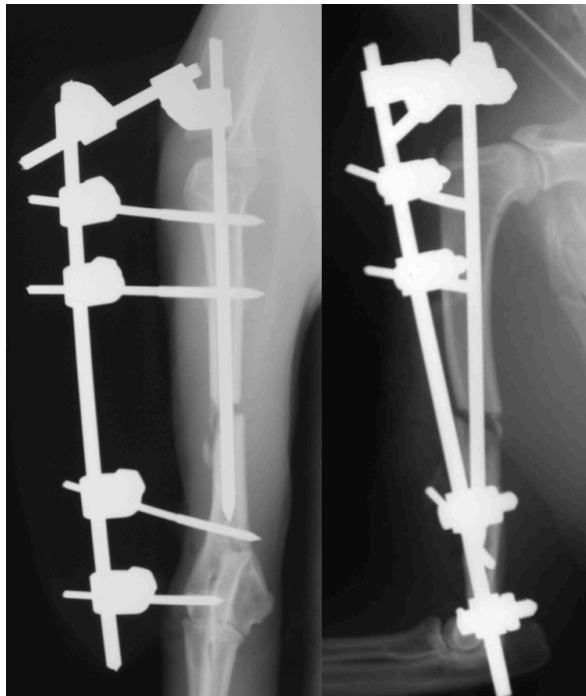
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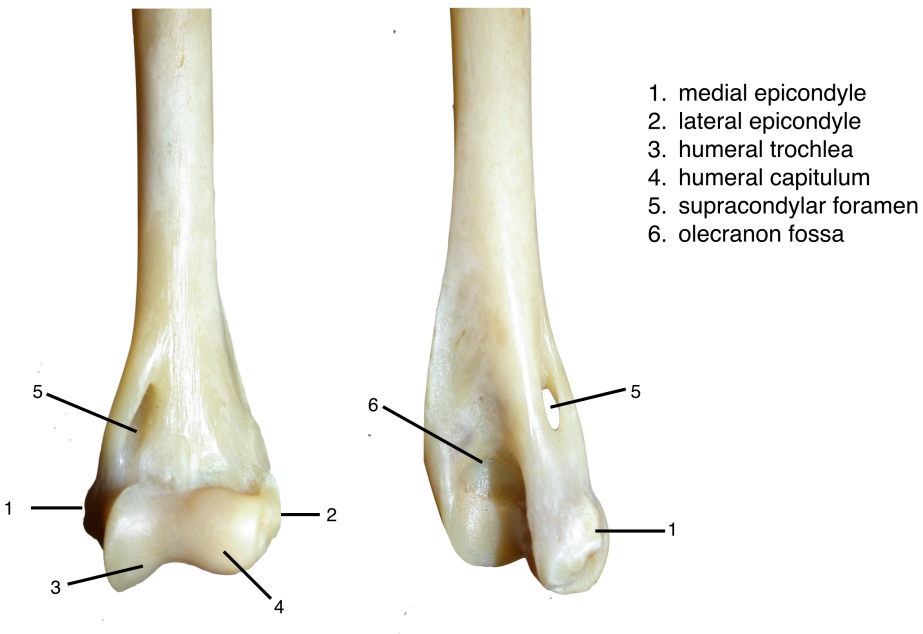
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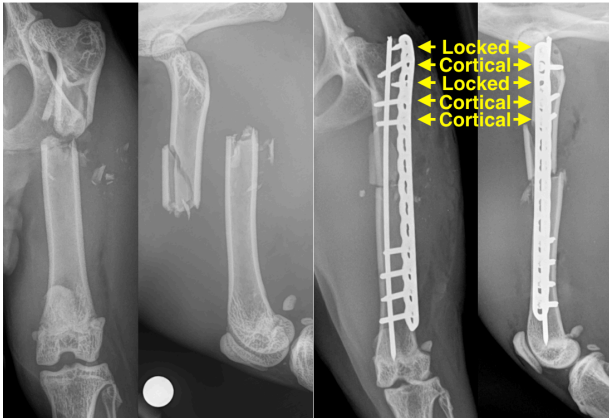
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Competency 2		Select and plan appropriate treatment options	
Question 2		Level of difficulty: Difficult	Difficult (postcourse)
		<p>This cat suffered an iatrogenic injury during the surgical repair of this comminuted humeral fracture.</p> <p>What structures pass through the supracondylar foramen in the cat that the surgeon should be aware of when repairing distal humeral fractures in cats?</p>	
Option A	Brachial artery and median nerve		
Option B	Cephalic vein and radial nerve		
Option C	Radial nerve		
Option D	Ulnar nerve		
Answer	A		
Rationale	The brachial artery and median nerve runs through the supracondylar foramen in the cat. Familiarity with the local surgical anatomy when repairing fractures is essential.		

	 <p>1. medial epicondyle 2. lateral epicondyle 3. humeral trochlea 4. humeral capitulum 5. supracondylar foramen 6. olecranon fossa</p> <p>Feline left humerus cranial aspect</p> <p>Feline left humerus caudal aspect</p>
Reference(s)	Color Atlas of Veterinary Anatomy, Volume 3. Done, Goody, Evans and Stickland. Mosby-Wolfe. 1996
Reviewer comments, etc	
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<b>Competency 3</b>	Perform operative and non-operative procedures to treat long bone fractures	
<b>Question 1</b>	Level of difficulty: Easy	Easy (postcourse)
		<p>This comminuted fracture has been repaired with a locking plate-rod combination.</p> <p>In the proximal fragment there are 2 locked screws and 3 cortical screws.</p> <p>When locked and cortical (unlocked) plate screws are combined in the one bone segment which ONE of the following statements is correct?</p>
<b>Option A</b>	It is necessary to place the locked screws prior to the cortical screws to ensure the plate is not compressed against the bone	
<b>Option B</b>	It is necessary to place the cortical screws prior to the locked screws to ensure friction is created between the plate and the bone	
<b>Option C</b>	Cortical screws should be attempted first. If the drill bit hits the pin a monocortical locked screw is placed instead of a bicortical cortical screw	
<b>Option D</b>	The order of screw placement is not important provided that there is a minimum of 7 cortices engaged in each bone segment	
<b>Answer</b>	B	
<b>Rationale</b>	<p>Cortical screws have some advantages over fixed angle locking head screws (LHS) in that they can be angled inside the plate hole (for example to avoid contacting the intramedullary rod or to avoid intra-articular screw placement when near a joint), they can be used as lag screws to create interfragmentary compression, and can be used to reduce fragments by pulling them up to a contoured bone plate.</p> <p>The disadvantage of cortical screws is that direct contact between the plate and the bone is necessary to allow load transmission axially along the screw length by a friction force. This is in contrast to LHS, which acts more like a bolt than a screw. LHS are not axially preloaded along the length of the screw and so the plate and the bone do not need direct contact to be effective.</p>	

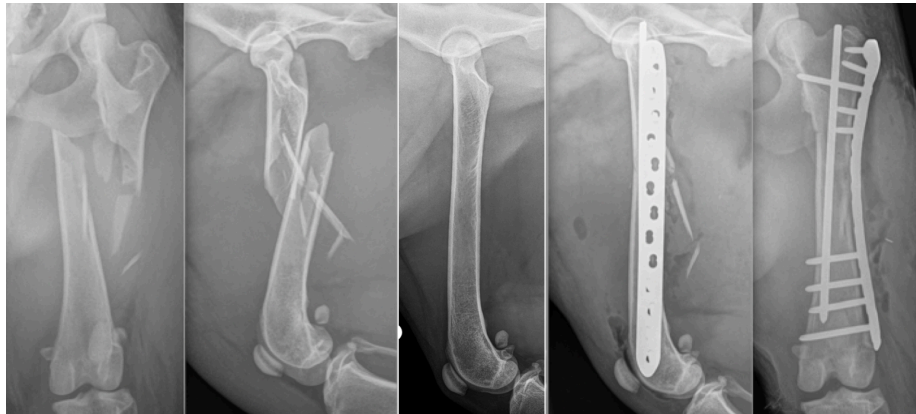
	For this reason it is necessary in hybrid screw placement (combination of cortex and LHS in one bone segment) to first place the cortical screws to ensure direct plate- bone contact and then to place any LHS. The motto is to “lag before you lock” wherein tightening the cortex screws “lag” or compress the bone to the plate.
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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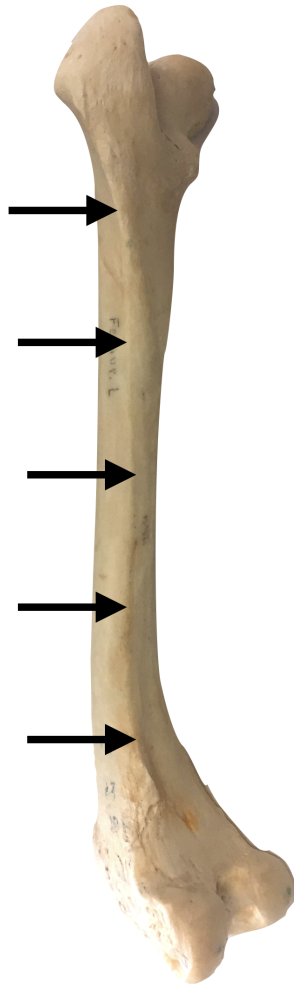
<b>Competency 3</b>	Perform operative and non-operative procedures to treat long bone fractures	
<b>Question 2</b>	Level of difficulty: Difficult	Difficult (postcourse)
		<p>You are planning a plate-rod repair of this traumatic Y fracture in a dog.</p> <p>Which ONE of the following statements regarding intramedullary (IM) pinning of the humerus is correct?</p>
<b>Option A</b>	Placing an IM pin from distal to proximal carries a risk of violating the articular cartilage of the humeral head.	
<b>Option B</b>	An IM pin cannot be used in conjunction with a locking plate due to interference with screw placement by the pin in the distal metaphysis.	
<b>Option C</b>	Retrograde IM pin placement exiting the pin distally safely avoids the articular cartilage of the elbow and the ulnar nerve.	
<b>Option D</b>	If placing an IM pin normograde from distally, the pin entry point should be immediately caudodistal to the origin of the superficial and deep digital flexor muscles.	
<b>Answer</b>	D	
<b>Rationale</b>	<p>Distal normograde pin placement from the medial aspect of the condyle allows safe pin implantation while also allowing application of a locking plate on the medial aspect of the humerus without interfering with subsequent locking screw placement.</p> <p>Retrograde placement of an IM pin distally may violate the articular cartilage or entrap the ulnar nerve.</p> <p>Due to the relationship of the proximal humerus to the diaphysis, an IM pin will exit cranial to the articular surface of the humeral head.</p>	





<b>Reference(s)</b>		Milgram J, Hod N, Benzioni H. Normograde and retrograde pinning of the distal fragment in humeral fractures of the dog. Veterinary Surgery. 2012 Aug 1;41(6):671-6.  Pearson T, Glyde M, Hosgood G, Beierer L. Distal normograde intramedullary pin and locking plate placement in the canine humerus: A cadaveric study. Veterinary Surgery. 2016 Oct 1;45(7):879-86.
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Competency 4		Formulate plans for postoperative care including recognition and management of complications	
Question 1	Level of difficulty: Easy		Easy (postcourse)
			<p>This fracture was repaired with a plate-rod. Assessment of alignment shows a normal femoral neck anteversion angle of approximately 30° similar to the contralateral.</p> <p>Which ONE of the following options can be used in surgery to help align the bone fragments to achieve a correct anteversion angle?</p>
Option A	Ensuring a normograde IM pin is placed to distract and align the fracture prior to plate application		
Option B	Identify and align the linea aspera on the caudolateral aspect of the proximal and distal femur fragments		
Option C	Pre-contour the bone plate prior to surgery based on a pre-operative radiograph of the intact contralateral femur		
Option D	Ensure that the stifle and hock joints are positioned exactly in a horizontal plane prior to plate application		
Answer	B		
Rationale	<p>External rotation (supination) of the proximal femur occurs most commonly after fracture and needs to be corrected at the time of surgery to prevent postoperative torsional malalignment.</p> <p>Aligning the lateral lip of the facies aspera, often called the linea aspera, helps achieve the correct anteversion angle.</p> <p>The lateral lip is identified with arrows in this image.</p>		




**Reference(s)**

Measurement of the femoral neck anteversion angle in the dog using computed tomography. Ginja, MMD et al. The Veterinary Journal 174: 378-383, 2007

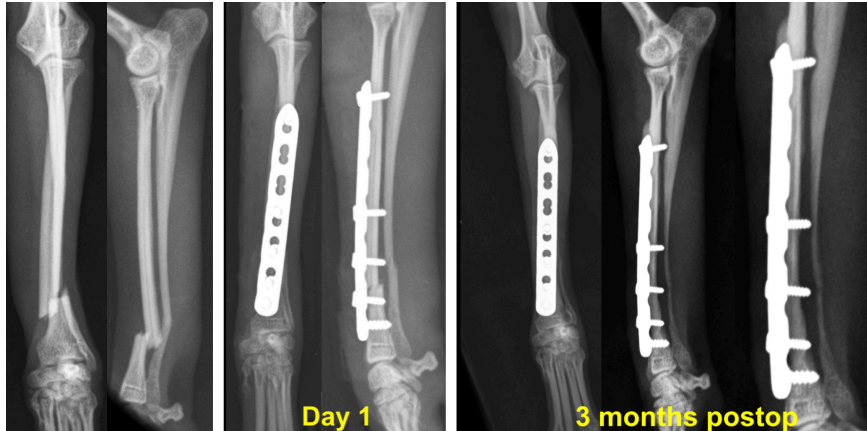
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<b>Competency 4</b>	Formulate plans for postoperative care including recognition and management of complications		
<b>Question 2</b>	Level of difficulty: Difficult	Difficult (postcourse)	
		<p>You have just completed a pancarpal arthrodesis (PCA) with a hybrid PCA plate on a dog and you are considering whether to apply a palmar fiberglass splint.</p> <p>Which ONE of the following statements regarding pancarpal arthrodesis with a hybrid PCA plate and palmar splints is correct?</p>	
<b>Option A</b>	Implant failure following PCA with a hybrid PCA plate occurs in almost 1/3 of dogs when palmar splints are not used		
<b>Option B</b>	Implant failure after PCA with a hybrid PCA plate is less likely to occur if a palmar splint is used		
<b>Option C</b>	Application of a palmar splint has been reported to cause complications in almost 1/3 of dogs		
<b>Option D</b>	Using a full (360°) fiberglass cast has been shown to significantly reduce complications compared to using only a palmar fiberglass splint		
<b>Answer</b>	C		
<b>Rationale</b>	<p>In a retrospective case series of hybrid PCAs, complications due to palmar splint external coaptation occurred in 32% of cases. Complications occurred in 45% of cases where a full cast was used.</p> <p>Biomechanical testing of hybrid PCAs showed that while splints reduced the magnitude of plate strain even without a splint the plate strain was below a level that was likely to cause implant failure.</p>		

	Bristow et al reported implant failure after hybrid PCAs in 11% of dogs where palmar splints were used. In a separate study Ramirez and Macias reported implant failure in 1/15 dogs where no palmar splints were used.	
<b>Reference(s)</b>	<p>Bristow PC, Meeson RL, Thorne RM, et al. (2015) Clinical comparison of the hybrid dynamic compression plate and the castless plate for pancarpal arthrodesis in 219 dogs. Veterinary Surgery. 44 (1), 70-77.</p> <p>Ramirez JM and Macias C. Pancarpal Arthrodesis Without Rigid Coaptation Using the Hybrid Dynamic Compression Plate in Dogs. Veterinary Surgery 45 (2016) 303–308</p> <p>Woods S, Wallace RJ, Mosley JR The effect of external coaptation on plate deformation in an <i>ex vivo</i> model of canine pancarpal arthrodesis. Vet Comp Orthop Traumatol 2012; 25: 439–444</p>	
<b>Reviewer comments, etc</b>		
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Competency 5		Critically assess patient outcomes	
Question 1		Level of difficulty: Easy	Easy (postcourse)
		<p>These are the pre-op, immediate post-op and 3 month follow up x-rays from a 16 month old 1.5kg toy breed dog.</p> <p>The closed fracture was repaired with a 2mm LCP. The distal screw is a 2mm locked screw. The other screws are 1.5mm cortex screws which were 34% of the bone diameter at the level they were placed.</p> <p>At 3 months post-op the radius and ulna fractures have healed and the dog is consistently weight-bearing.</p> <p>With regard to the resorption of ulna bone which ONE of these statements is correct?</p>	
Option A	Resorption of the ulna has occurred due to stress shielding because the plate is too stiff for the bone		
Option B	Resorption of the ulna has occurred due to the 2 <sup>nd</sup> and 3 <sup>rd</sup> screws contacting the ulna and causing irritation.		
Option C	Resorption of the ulna has occurred due to failure to stabilize the ulna.		
Option D	Resorption of the ulna is highly suggestive of cryptic infection.		
Answer	A		
Rationale	<p>Bone resorption occurs due to disuse and / or lack of biomechanical stimulation. In this case the dog was weight-bearing consistently so disuse is highly unlikely to be the cause.</p> <p>A lack of biomechanical stimulation can occur when an implant is too stiff and prevents the bone sharing enough load. This is called stress shielding or stress protection. Wolff's law explains why bone is resorbed in these cases. Similar resorption would be occurring to the radius however this is difficult to appreciate because of the plate overlying the radius.</p> <p>The 2<sup>nd</sup> and 3<sup>rd</sup> screws do not impinge on the ulna. It is only in the proximal ½ of the radius that the ulna is at risk of screw impingement from plate screws of appropriate length. The most proximal screw is impinging on the ulna and this causes focal bone resorption rather than the more general resorption that has occurred in this case.</p>		

	Stabilisation of the ulna was not necessary in this case and would have created more stress shielding as the radius fixation was already relatively too stiff. There is no clinical or radiographic evidence to suggest infection.
<b>Reference(s)</b>	Frost HM. Bone “mass” and the “mechanostat”: a proposal. The Anatomical Record 219 (1), 1-9. (1987)  Griffon D. Bone resorption; In: Complications in Small Animal Surgery, 1st Edition. Ed Griffon D on and Hamaide A. John Wiley & Sons, Inc. 97; 658-664. (2016)
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Competency 5		Critically assess patient outcomes	
Question 2		Level of difficulty: Difficult	Difficult (postcourse)
		<p>This broken 4.5mm shaft screw had been placed to treat a humeral condylar fissure in a two-year-old springer spaniel.</p> <p>18 months following surgery the dog became lame and it was found that the screw had broken.</p> <p>Which ONE of these is the mechanism of long term screw failure in these cases?</p>	
Option A	Acute overloading due to a failure to confine the patient		
Option B	Defects in screw manufacturing		
Option C	Cyclic tensile forces on the screw		
Option D	Cyclic multi-directional forces on the screw		
Answer	D		
Rationale	Healing of humeral condylar fissures is rarely seen following surgery, meaning that screws are subject to long term cyclic forces. Assessment of the mechanism of screw failure by electron microscopy has indicated multi-directional forces on the screw. At the time of initial surgery, owners should be warned that there is a risk of long term implant failure.		
Reference(s)	Charles EA <sup>1</sup> , Ness MG, Yeadon R. Failure mode of transcondylar screws used for treatment of incomplete ossification of the humeral condyle in 5 dogs. Vet Surg. 2009 Feb;38(2):185-91		
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