



CERVICAL INTERBODY SPACER

SURGICAL PROTOCOL

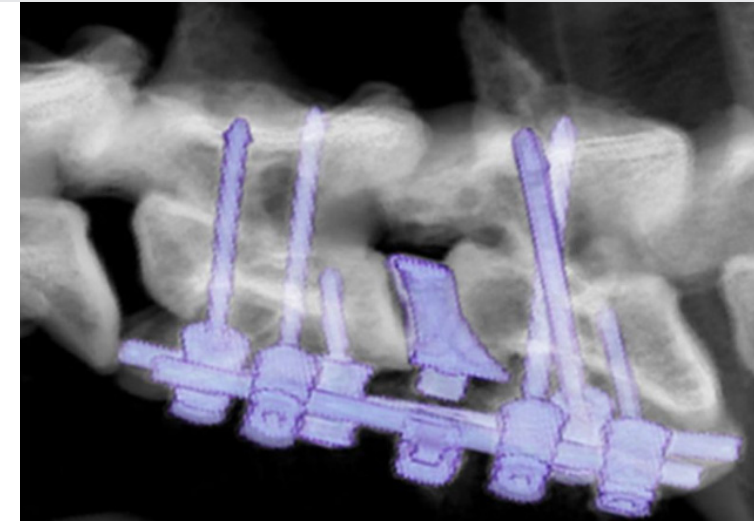
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Diagnostics

- Following MRI-based confirmation of disc- or osseous-associated wobblers syndrome, the patient should be moved to CT and positioned in dorsal recumbency within a trough, with the thoracic limbs extended caudally, the base of the neck built up with towels (sandbags can affect CT quality) and the chin taped down – perfectly mimicking the surgical position (as per a ventral slot decompression).
- Photographs can be useful at this stage so there is note of the exact positioning of the patient and which trough and towels were used. These can be referred to when positioning the patient in theatre.
- CT images should extend from the occipital bone to the level of the 3rd rib.
- A bone algorithm should be used, the raw data sent in compressed format to Fusion implants via We Transfer or another mass transfer system.



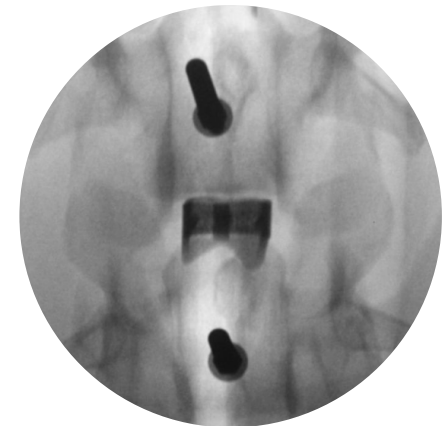
Surgery

- The surgical clip extends from the chin to the level of the 3rd to 5th rib, wide enough in the cervical region by a few inches and wide enough at the shoulder to ensure at least one or both proximal humeri are exposed.
- The patient is moved to theatre and positioned identically to the position in CT with draping to expose one or both proximal humeri dependant on how much graft is to be harvested. The use of a patient trough is recommended – ideally the one used in pre-op CT.
- Bone graft is harvested from one (single level fusion) or both (multiple level fusion) proximal humeri in the published way. Bone graft is put to one side and covered in a moist swab pending application later in the procedure. The bone graft sites are closed prior to the next stage.
- A standard ventral approach to the caudal cervical spine is made and the appropriate disc space is identified.
- Exposure of the ventral vertebral bone surfaces is further facilitated using lempert/double action rongeurs to remove excess muscle and a beaver blade to scrape the bone surface clean. Two pairs of deep angled gelpis should be used for muscle retraction.
- The bone should be exposed such that the drill guides can be satisfactorily positioned prior to removal of the intervertebral discs. The surgeon should be confident that the drill guides fully engage the ventral surface of the bone and that slight off-axis pressure does not disrupt their position.
- The ventral annulus should be resected using the beaver blade and nuclear extirpation can proceed as far as is possible prior to distraction (as the distraction pins partially obstruct extirpation). Extirpation is facilitated by house curette, small periosteal elevators, fine tipped rongeurs and beaver blade. Care should be taken in removing spondylosis deformans in case this tissue is integral to the position of drill guides. The fibro-osseous end-plates should be gently curreted.



Surgical technique, ventral view of cervical spine: intra-operative fluoroscopic image demonstrating adequate positioning of interbody spacer.

- Using the 3D model and drill guides, the correct positioning of the distraction pins should be established. This is ideally mid-vertebral body to the 1/3 of a vertebral body adjacent to the disc space being fused; or at least avoiding the vertebral endplates wherever possible. The pins should be placed perpendicular to each other in a vertical plane and on mid-line of the vertebra in a sagittal plane. A small (1.8mm to 2.4mm) high-speed burr can be used to penetrate the vertebral cortex in the correct locations for pin insertion. The pins are self-drilling and self-tapping so can be driven into the cancellous bone without the need for a drill bit. The appropriate distance of insertion should be estimated from pre-operative imaging; the threaded portion of the pins are 12mm but often the vertebral body is narrower than this, particularly in the mid-portion.
- The Caspar vertebral distractor can then be applied, and some traction applied to facilitate further cleaning of the disc space and general curettage of the vertebral end-plates. The sleeves of the caspar distractor should be driven as far down the distraction pins as possible (this is facilitated by correct placement of the pins).
- Traction can then be applied at close to maximum facilitated by the soft-tissues. Care should be taken to fully expose and slightly thin the fibres of the dorsal annulus and gently remove the disc/cartilage at the craniodorsal portion of the endplate which is not easily visible to the surgeon.
- The spacer can be 'test fitted' into the disc space with traction applied. The spacer is manipulated with a pair of pin-pullers or needle holders clamped to the insertion 'fin'. It is worth inserting some bone graft into the centre of the spacer in case the fit is immediately perfect to avoid the need to remove and re-insert. Sometimes, the spacer will suddenly clunk into place if the spacer is pushed past the centre of the end-plate into the craniodorsal portion of the end-plate. Do not try to forcibly insert the spacer.
- If the fit is not adequate, further traction or further removal of disc/cartilage may be required. Rarely, the surgical position may not fit with the CT position and it may be necessary for a colleague to adjust the position of the dogs neck under the drapes and/or add or remove the materials used to position the neck.
- When the fit is adequate, the traction can be released and the distractor removed. The spacer will remain in-situ with friction. Intra-operative fluoroscopy or digital x-ray can be used to confirm the spacer is sitting correctly in the disc space.
- The traction pins are removed. It may be necessary to fill the insertion holes with bone wax if they are bleeding.
- The drill guides are applied to the vertebra. Firm on-axis digital pressure should be applied to prevent guide slippage. In the case of C7, particularly in deep chested breeds, a surgical assistant may be required to remove the gelpis and manually adjust and rotate the soft-tissues to facilitate access to the guides. The surgeon can then use one hand to stabilise the guide and one hand to drill the holes. We would recommend an anti-skid drill bit with a short 'spike'. A single drill bit should be used; we would not recommend leaving one in the guide to drill the other as this might exacerbate any errors should the guide have lifted when the bone is penetrated. This should be avoided with firm pressure, the use of an anti-skid drill bit, and the use of newer sharper drill bits.



- We would recommend marking the drill bits to indicate to the surgeon drill depth (see below reason). The best way to do this is with a drill stop or a small piece of adhesive drape (as pen marks are often smudged). This helps improve confidence. Fusion implants may supply pre-marked drill bits.
- It is necessary to drill both holes (or more in the event of using mono-cortical screws) before the guide can be removed. Bleeding from drill holes between hole drilling can be dealt with during the process by applying bone wax or in the event of severe bleeding, the guide is removed, suction is applied to the drill hole by an assistant, and bone wax is firmly applied. With profuse bleeding, firm application of a swab to the drill hole may be required between removal of the suction and application of bone wax. Bleeding can be experienced from the cancellous bone, the basi-vertebral vein, the venous sinuses (if the holes encroach on the intervertebral foramen) and rarely the spinal artery if the drill trajectory is marginally inaccurate. As long as the surgeon is prepared, significant bleeding can be dealt with quickly.
- Sometimes when drilling for a bi-cortical screw, especially in C6, the surgeon will experience low resistance during the cancellous bone of the vertebra, then firm resistance in the pedicle, then another loss of resistance in the cancellous bone of the lamina and/or penetration of the cortex. Drilling should continue to the mark on the drill bit.
- The screws are inserted, being careful to adhere to the same trajectory of the drill holes. The 3D model with drill holes can be used to check the trajectory using a small pin or drill bit. Insertion depth is determined from pre-operative imaging and is dependent on the stabilisation system employed. A small mark can be made on the screw to improve confidence in appropriate depth.
- Once all screws are inserted, the connecting rods can be applied. It may be necessary to burr a portion of the caudal vertebral end-plate of the cranial vertebra being fused to facilitate adequate insertion of the rods and to make the rods parallel. This helps fusion when graft is applied. This is not necessary if bone cement is being used. In this case, the screw heads are filled with bone wax to assist with revision if necessary.
- The pedicle screw nuts are applied and moderately tightened whilst the rod is pushed down firmly into the tulips. Nuts are tightened sequentially without proceeding too far with one nut at once.
- The connecting rod(s) can be applied, if the nuts are loose they are clamped on with finger pressure before tightening.
- The pedicle screw nuts are then tightened fully using a torque limiting screw driver.
- Bone graft is mixed with DMB allograft and this is then packed lateral to the intervertebral spacer and over the top of the pedicle-screw-rod construct.
- It is rarely possible to close the longus colli muscle, so a couple of pieces of lightly moistened lyostypt are used to cover the graft and help prevent migration by friction.
- Closure is otherwise routine.
- Post-operative CT is used to determine satisfactory implant placement and vertebral alignment.

Post-operative expectations

- 2 nights of hospitalisation is normally required post-operative.
- Neurologic deterioration is not typically seen after the procedure, but a degree of lameness can be seen and might relate to the bone graft collection or the procedure.
- Thoracic limb paresis is a sign of subsidence onto the implant. This has been seen 2-3 days after the procedure, but only with mono-cortical fixation. It can normally be managed medically.
- At discharge we normally recommend the following exercise protocol:

Weeks 0 - 3: Short, controlled lead walks for toileting purposes only, 4-5 times daily, of approximately 5 minutes duration. When not supervised he should be rested in a small room, or penned area.

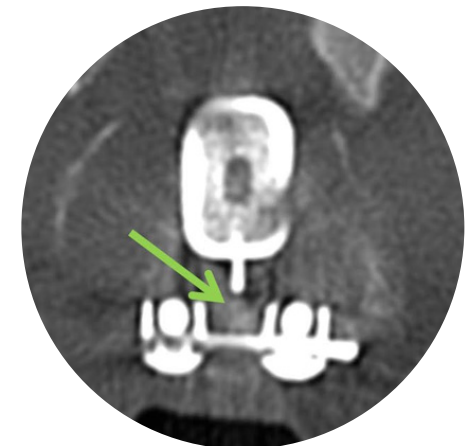
- **Weeks 3 - 6:** Introduce short lead walks, twice daily, of 10-15 minutes duration. He should still not run, jump or climb stairs. He can have free access to the house but should not climb stairs and he should be discouraged from jumping up or onto sofas, beds, etc (he can climb or can be lifted).

- **Weeks 6-9:** Increase length of twice daily lead walks by 10 minutes each week. A longer or extendable lead could be used to allow some light trotting. The walks can be split into three walks if preferred. He can climb stairs under close supervision.

- **Weeks 9-12:** As above, with supervised short periods of off-lead exercise, avoiding rough play with other dogs or strenuous activity in uneven, very wet or boggy terrain.

- **Weeks 12+:** Normal exercise with off-lead activity. Long-term, it may be sensible to avoid long flights of stairs, large drop-offs (logs, walls, etc), and very rough play with other dogs.

- Follow-up sedation for CT is recommended at 3 and 12 months post-operative.



Bony ventral bony bridging suggesting endoprosthetic osseous fusion.