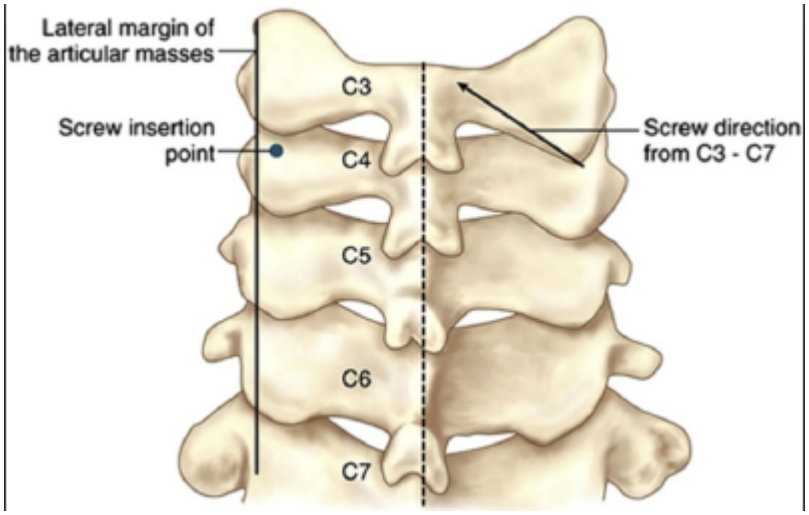
Cervical pedicle screw placement

see C1 pedicle screw placement.

see C2 pedicle screw placement.



see also Thoracic pedicle screw placement

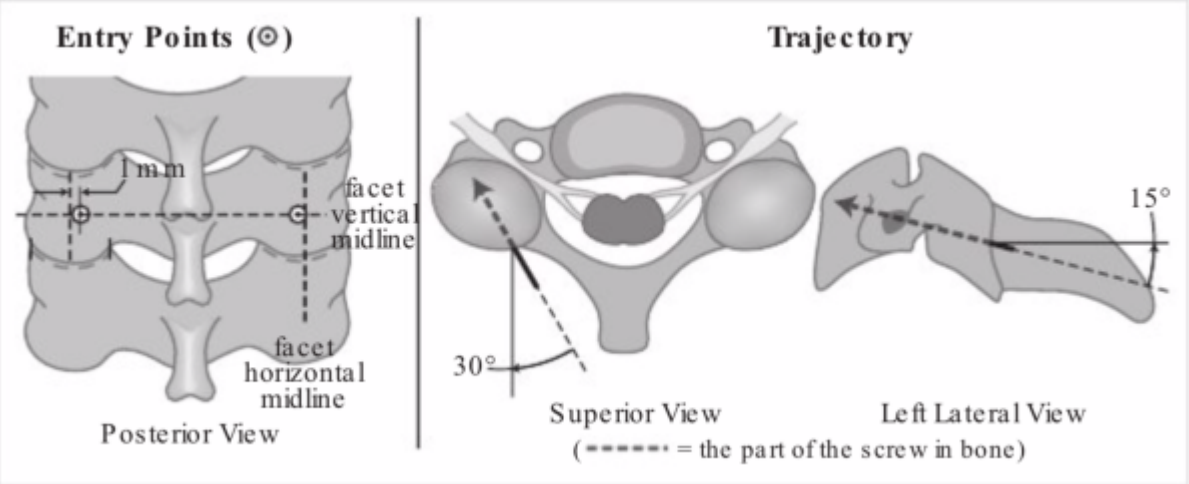
see also Lumbar pedicle screw placement.

C3–6 fixation

Lateral mass screws

Method	Entry point		Trajectory angle	
	Medio-lateral	Cranio-caudal	Medio-lateral	Cranio-caudal
An	1 mm medial to mid-point	midpoint	30° lateral	15° cephalad
Magerl	2 mm medial to midpoint	2 mm cranial to midpoint	20–25° lateral	parallel to facet joint[a]
Roy-Camille	midpoint	midpoint	0–10° lateral	0°

[a]angle can be determined by inserting probe into the joint



Generally applicable to C3–6. The lateral masses of the thoracic spine are usually too small and not strong enough for these screws. C7 is a transitional level, and lateral mass screws may sometimes be used.

Occasionally even T1 may be amenable.

Technique:

A number of methods have been promulgated with various screw entry points and trajectories.

Comparing 3 techniques there was a lower risk of nerve injury with the following:

1. ENTRY 1 mm medial to the midpoint of the lateral mass.In the cranial-caudal direction, the midpoint is used. A Penfield 4 may be used to palpate the medial wall of the pars to help determine entry point and trajectory

2. TRAJ 30° laterally, 15° cephalad (editor's note: for upper cervical levels more cephalad trajectory is used, for caudal cervical levels 15° or less may be closer). To get the lateral angulation, the holes are best drilled from the contralateral side of the patient, holding the drill shaft almost up against the spinous processes (if they are still present).

a) SCREWS 3.5 mm diameter,14–16mm length (for C3–6)

b) rod size: 3.5 mm diameter rods are usually used, and can be placed as far caudally as T3 as long as there is not gross instability (below T3, 5.5 mm diameter rods are used either via transitional rods or with rod connectors, e.g. "domino" connector)

Spinous process wiring may be used with intact spinous processes to help secure the bone graft.

Transarticular screw fixation

An alternative to lateral mass fusion. First described in 1972 by Roy Camille. May be used alone or as an anchor point.

1. PROS:

a) screws cross 4 cortical surfaces for better purchase

b) compresses across the joint to promote fusion

c) useful at cervico-thoracic junction where trajectory preserves facet capsule

d) lower implant profile

2. CONS: cannot correct deformity

3. ENTRY midpoint of lateral mass

4. TRAJ perpendicular to joint, neutral to 5° lateral(to avoid VA and exiting root).

5. biomechanics: stability equivalent to lateral mass screws

6. clinical: 25 patients (81 screws), 71 anchor, 10 fixation, 3.5 years F/U: solid fusion, no complications.

Translaminar cervical screw fixation

May be used in cervical or thoracic spine.

1. indications: salvage technique when anatomy precludes pedicle screws.

2. PROS:

a) avoids complications related to pedicle screws

b) no need for fluoroscopy (reduces radiation exposure)

3. CONS: requires intact posterior elements (cannot do with laminectomy)

4. ENTRYcontralateral spinolaminar junction (at base of spinous process)

5. TARGET junction of the transverse process and the superior facet contralateral to the entry point

6. SCREWS 3.5–4.5 mm ×26 mm polyaxial screw

7. biomechanics: no data

8. clinical: 7 patients (C-T fixation), 14 months F/U, no hardware complications. Inconsequential ventral penetration in 5%.

C7 screws

C7 is a transitional level, and as a result either the lateral masses or the pedicles or both may be relatively small.

Screw fixation options:

1. pedicle screws: recommended especially when the C7 lateral mass is of inadequate size for lateral mass screws. Placement with fluoroscopy may be difficult due to shoulder artifact on lateral fluoro, and direct visualization of the medial wall of the pedicle may be required as in the thoracic spine

2. lateral mass screws:

a) ENTRY as for C3–6

b) TRAJ compared to C3–6 screws, slightly less lateral at ≈ 15° and a little less cephalad at ≈ 10° c) SCREWS3.5 mm diameter,14 mm length

d) biomechanics: lab studies indicate that C7 lateral mass screws are biomechanically equivalent to C7 pedicle screws in constructs extending down to C7

3. C7 transfacet screw:

a) PROS: reduced risk to spinal cord and nerve roots

b) CONS: disrupts C7-T1 facet capsule, so T1 must be included in fusion. short screws result in low pullout strength ⊠may be best used as an intermediate anchor point and not an construct endpoint

c) ENTRY1–2 mm medial and superior to center of facet

d) TRAJ 30° inferiorly and 20°laterally, TARGET goal is bicortical purchase

e) SCREWS3.5mm diameter × 8–10mm polyaxial screws

f) biomechanics: equivalent to C7-T1 pedicle screws

g) clinical: 10 patients, long cervico-thoracic fixation, 6 months F/U, 3 patients with solid fusion.

Complications

Screw malposition varies from 0%–4% in the atlas and 0%–7% in the axis [1) 2) 3)].

Posterior fusion of the atlas and axis by transarticular screw fixation or Magerl screws pose an additional risk of Iatrogenic vertebral artery injury, neurological deficit or inadequate bony purchase.

Vertebral artery injury is one of the most dangerous complications of screw fixation and is usually due

to incorrect cervical pedicle screw entry with vertebral artery injury. The incidence of iatrogenic vertebral artery injury is 1.3%–4% for Magerl fixation [4]. Fortunately, the risk of neurological deficit is low (0.2%) [5]. Mortality is greatly increased if both vertebral arteries are injured. Lateral deviation of screws can often lead to penetration of the foramen transversalis and subsequent vertebral artery injury [6]. Current trends include the use of intraoperative CT and computer-assisted navigation systems to improve screw trajectory and reduce screw perforation [7] [8].

Subaxial lateral mass screws carry a risk of nerve root injury (1.3%) and lateral mass fracture [9].

Direct root injury during lateral mass screw insertion can be avoided with fluoroscopic control. Insertion under sagittal angulations of less than 15° may lead to impingement of the exiting nerve root by the protruding screw threads [10]. In axial trajectories greater than 30° lateral to the midline, lateral mass fracture (1.6%) or screw cut-out (1.3%) may occur [11]. However, neurological harm is not common. Screws placed too medially can cause vertebral artery injury.

Occipitocervical fusion Complications

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