
In the Name of God

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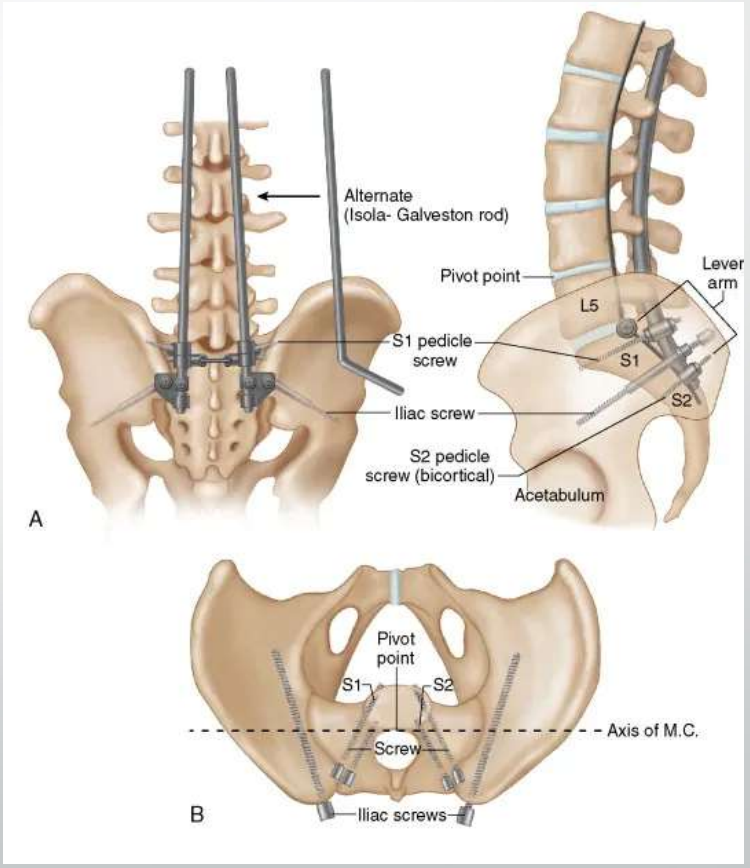
Technical Nuances & Complication Avoidance in Sacral Fixation

Sacral Screw Might be Challanging

- Pedicle screw fixation has become popular in worldwide.
- The sacral screw placement may not be a benign procedure.

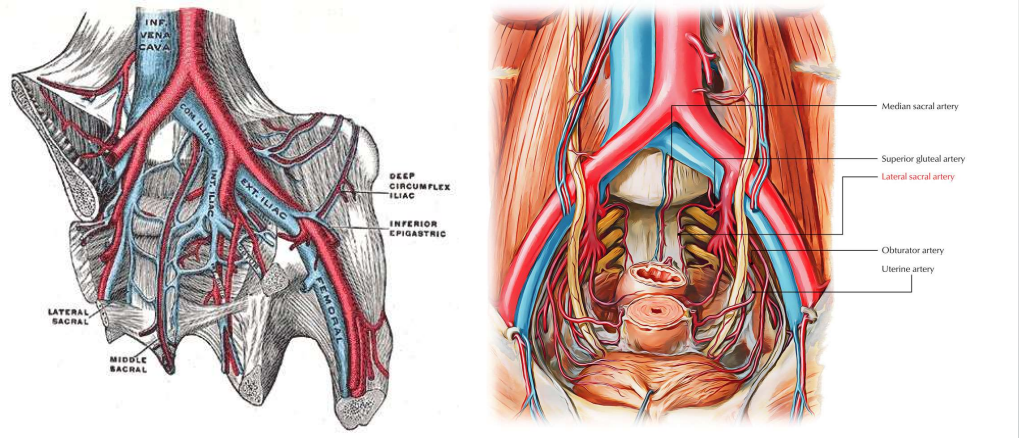


Anatomical Properties

- Biomechanically, sacrum is weaker than thoracolumbar spine.
- Thin cortical bone and more fatty tissue.
- Vertical orientation of the lumbosacral joint exposes the sacral spine to an increased risk of translational deformation.
- S1 Screws are subjected to posteriorly directed force during flexion that results in tendency for screw pullout.

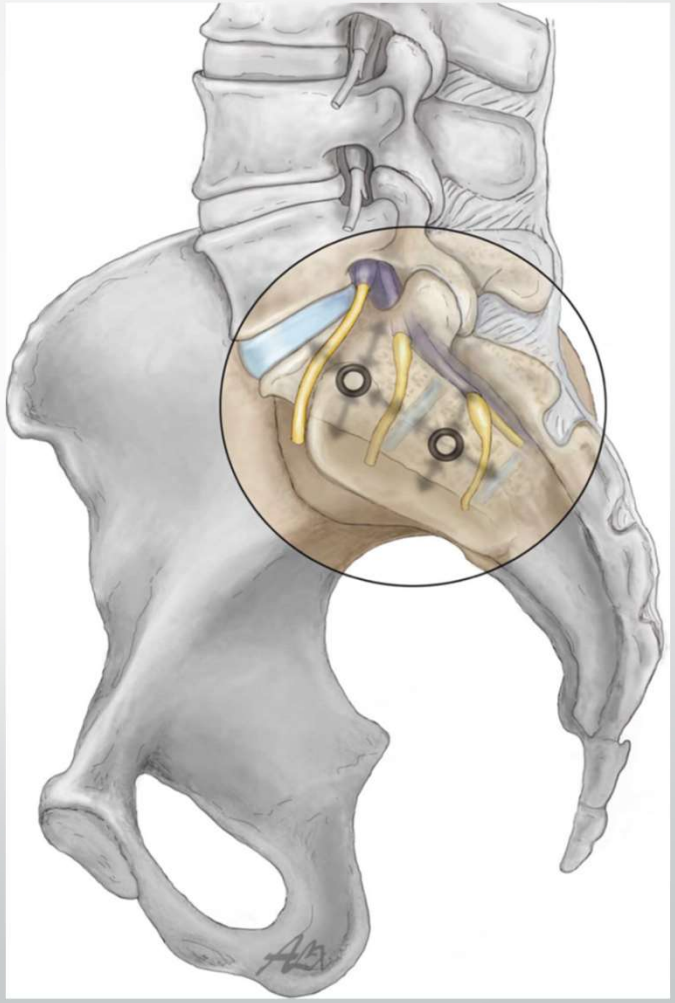
Elements at Risk

- Lumbosacral trunk
- S1 nerve root
- Internal iliac vein



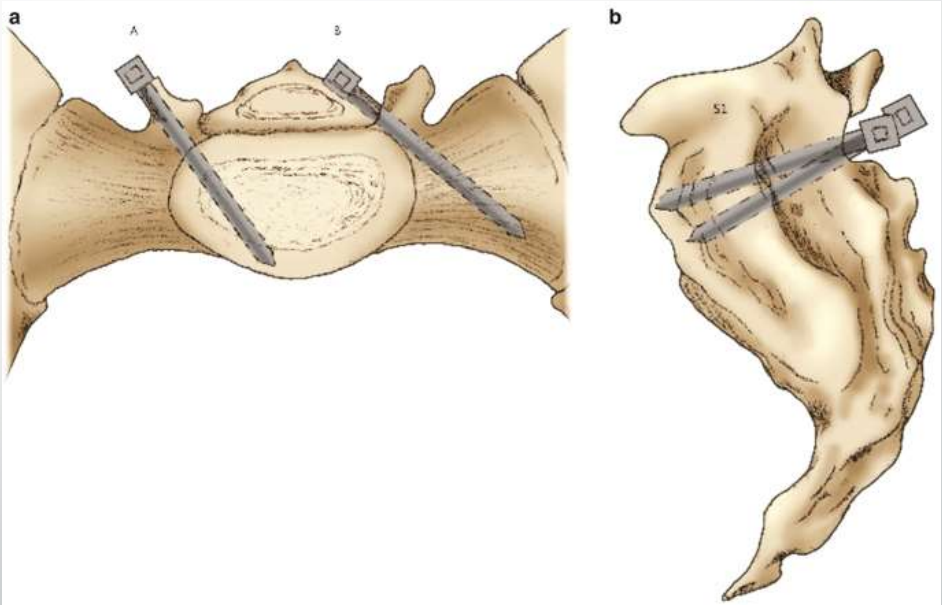
Complications

- Sciatica due to anterior screw penetration. (Camp et al).
- S1 root impingement as the screw was inserted too caudally. (Matsuzaki, et al)
- Radiculopathy which subsided after offending screws were removed and confirmed intraoperatively with electrical stimulation test. (6 cases)

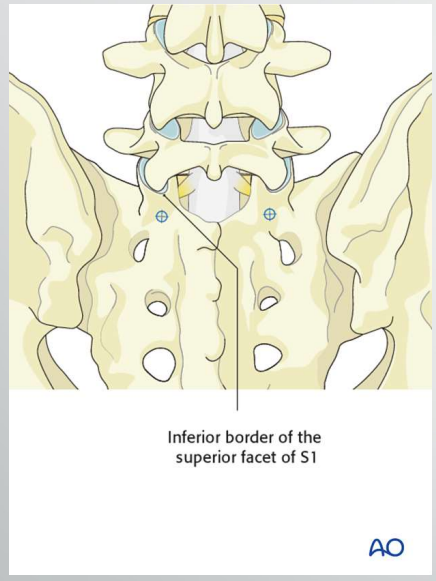


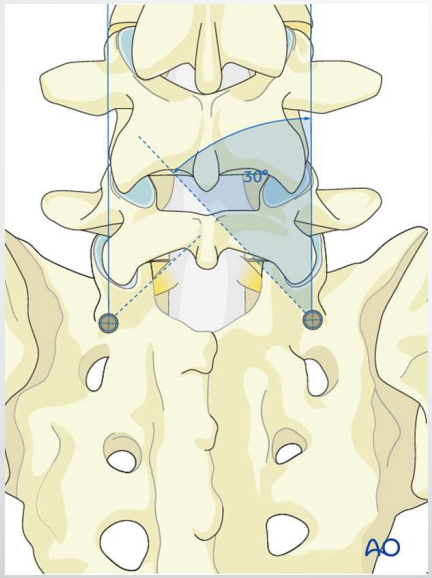
Sacral Screw Techniques

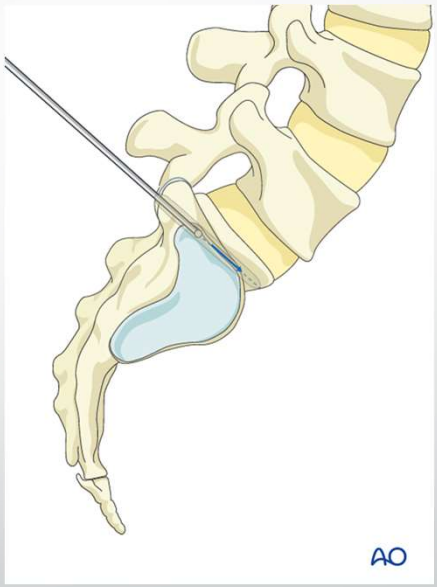
- Anteromedially into the sacral promontory
- Anterolaterally into the sacral ala

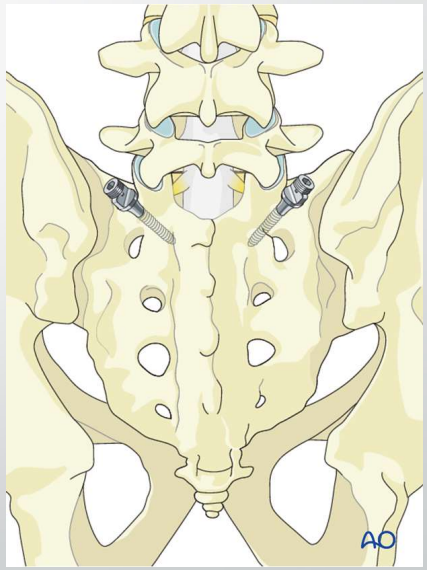


S1 Pedicular Screw



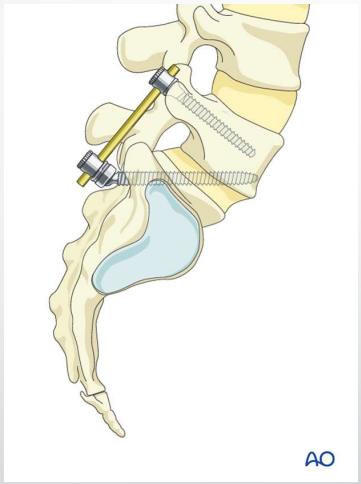


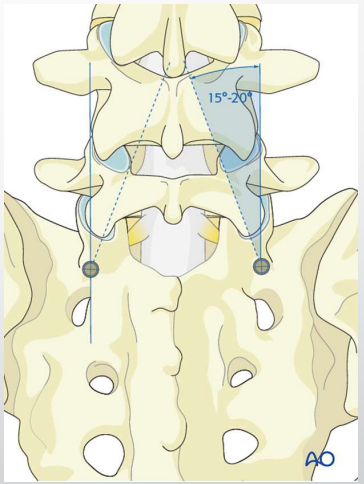


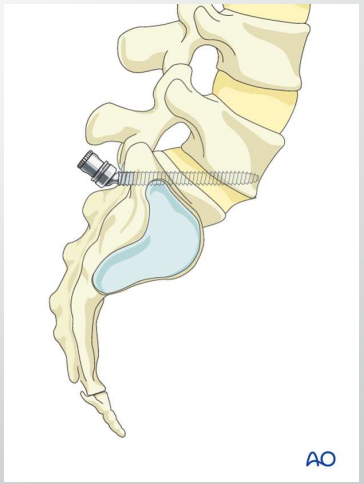


Screw insertion for delta fixation

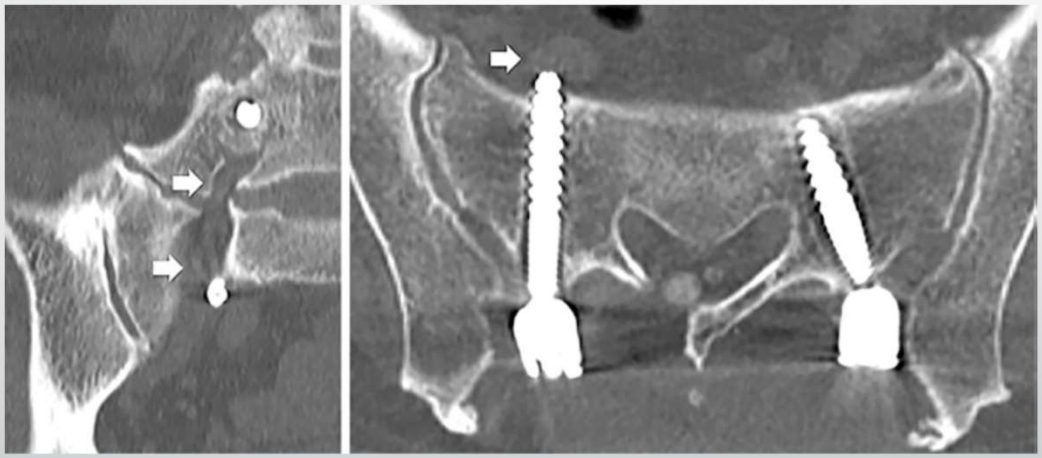
- More cranial oriented trajectory can be used.
- Where reduction is not necessary, but added stability is desired.
- The entry point remains the same as the standard S1 pedicle screw.





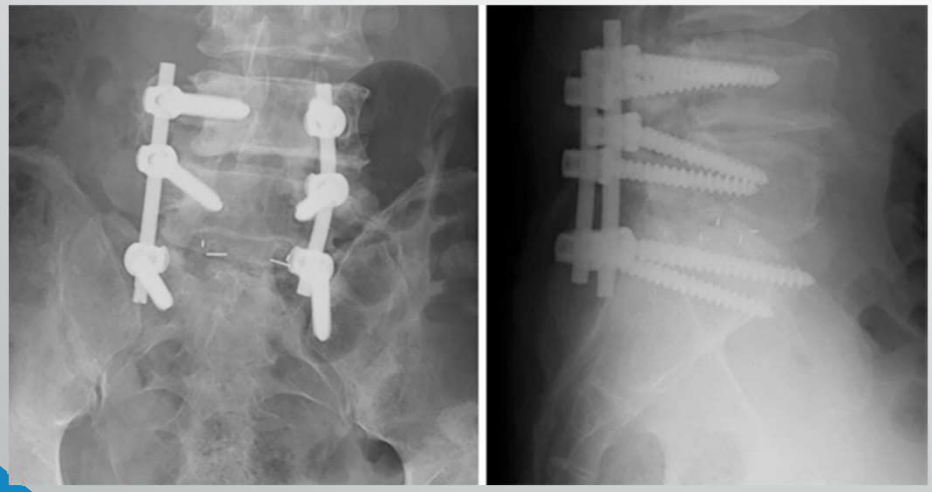


L5 Root Injury

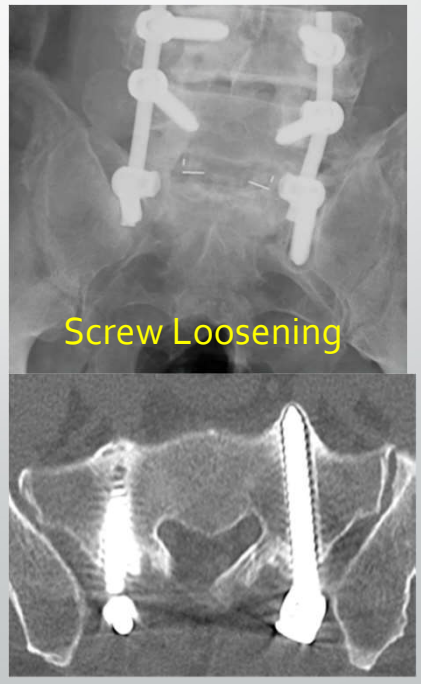


Delayed L5 Root Injury

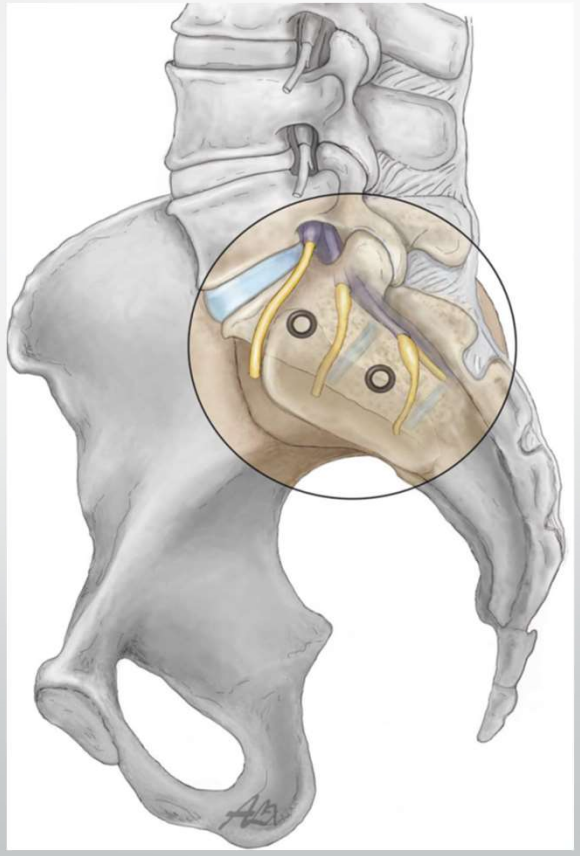
The screws were inserted toward the outside of the S1 anterior foramen, especially on the left side.



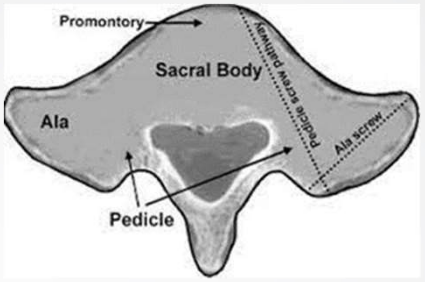
6 mo later



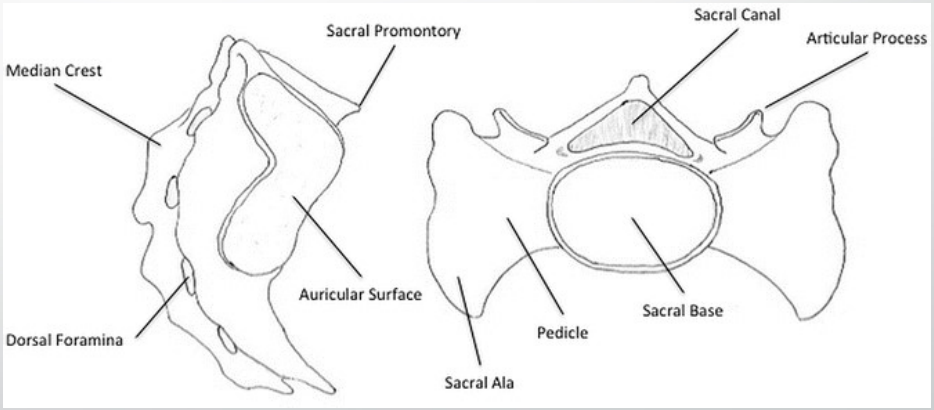
Ideal sagittal screw placement and the relation to the nerve roots of L5, S1 and S2



S1 Pedicle

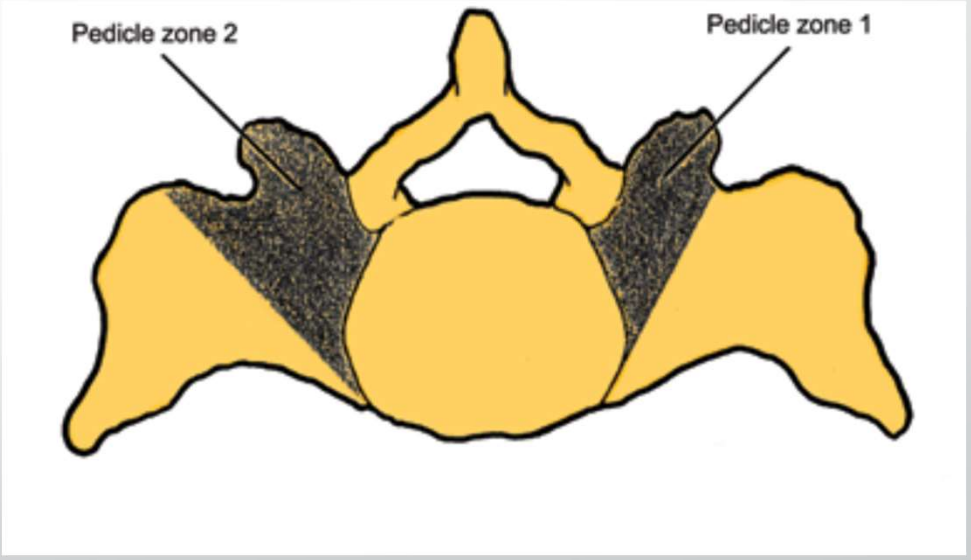


- The cephalad margin of the S1 pedicles lie under the most anterior aspect of the sup facet.
- The caudal margin is the sup edge of the S1 dorsal aperture.
- The medial margin of the pedicle is the lateral edge of the sacral canal.
- The lat margin of the S1 pedicle has yet to be defined.

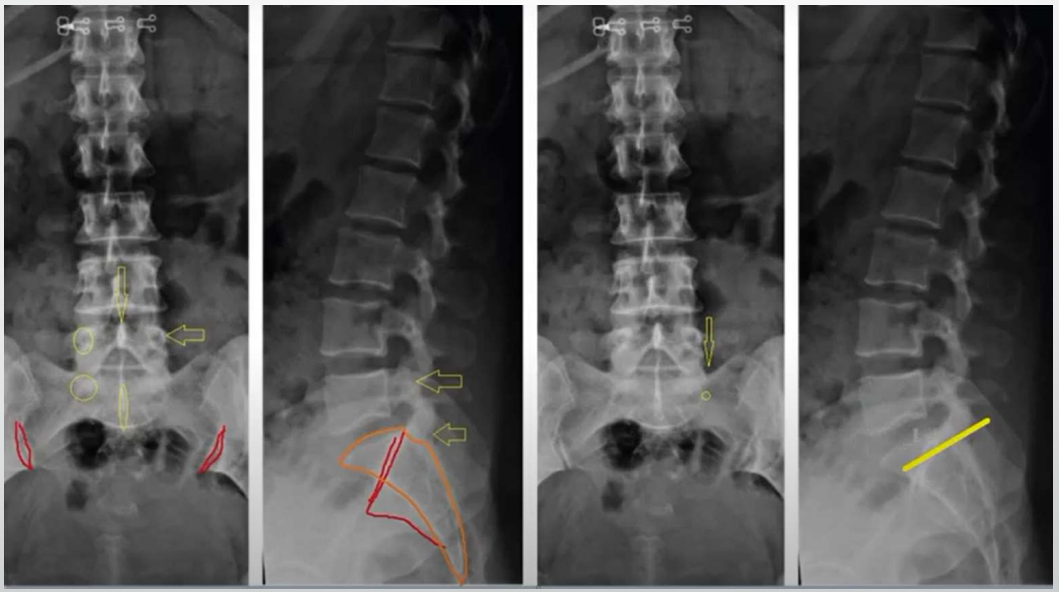


Sacral Pedicle Zones

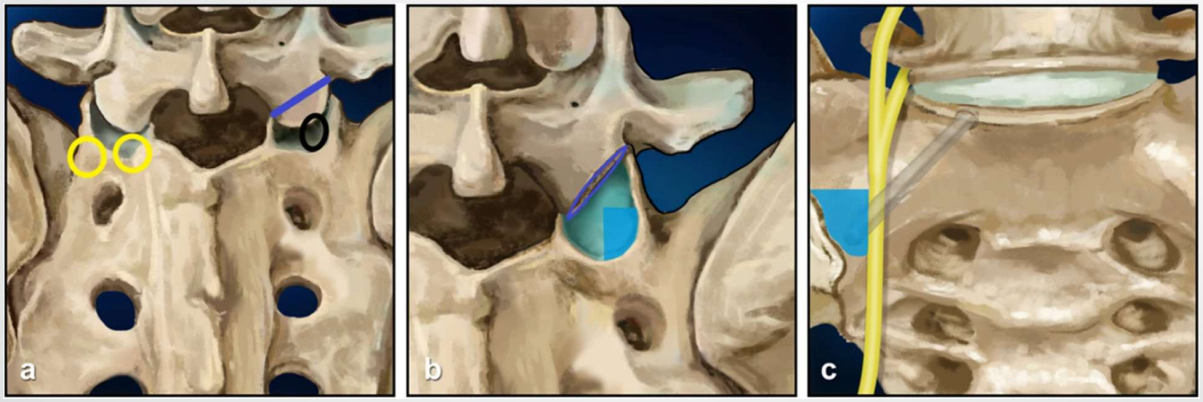
- Xu, et al. demonstrated that safer area for S1 pedicle insertion was in pedicle zone 2.
- Zone 2 : located between the lower lat portion of the L5-S1 facet and the lat sacral crest.



S1 Pedicular Screw



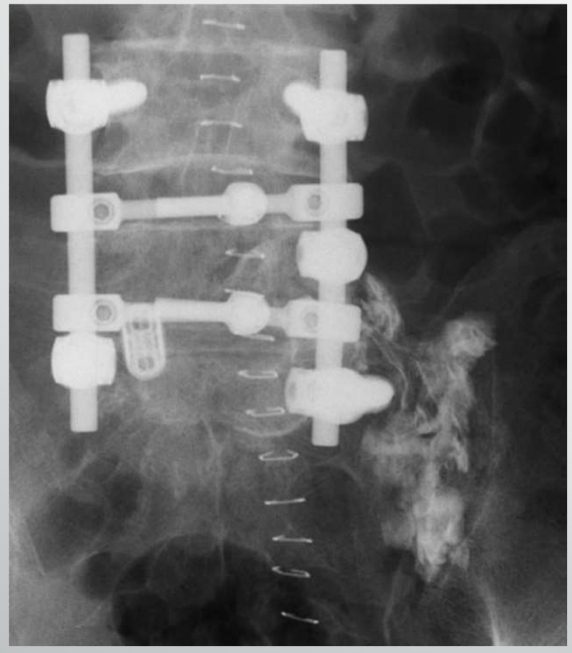
Anterolateral Technique

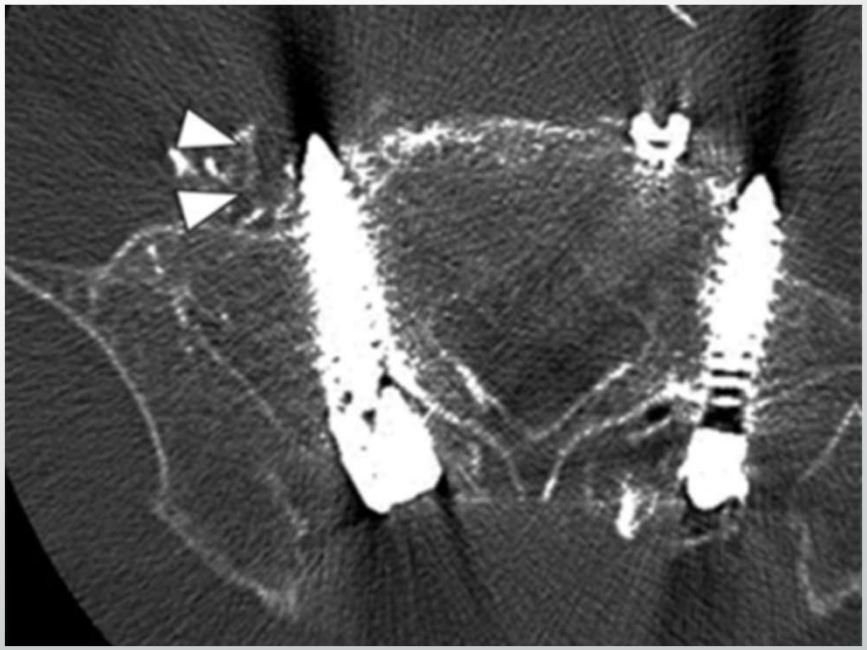


- The entry points (left two yellow circles) of S1 screws were medial and inferior to the S1 facet (Mirkovic,1991) and 5 mm inferior and 10 mm lateral to the S1 facet (Asher,1986).
- 30° lateral and 45° inferior at a depth of 40 mm into the lateral sacral ala
- Screws 7.0–7.5 mm in diameter and 35–45 mm in length.

L5 Root Injury:

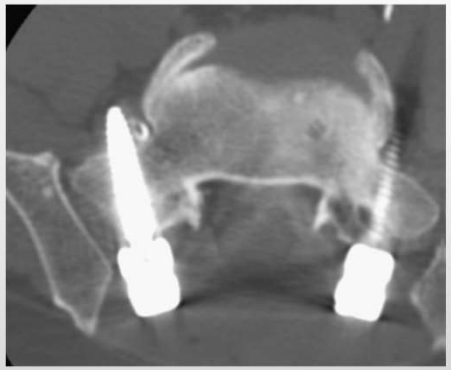
The L5 nerve root was compressed laterally by the perforating S1 screw





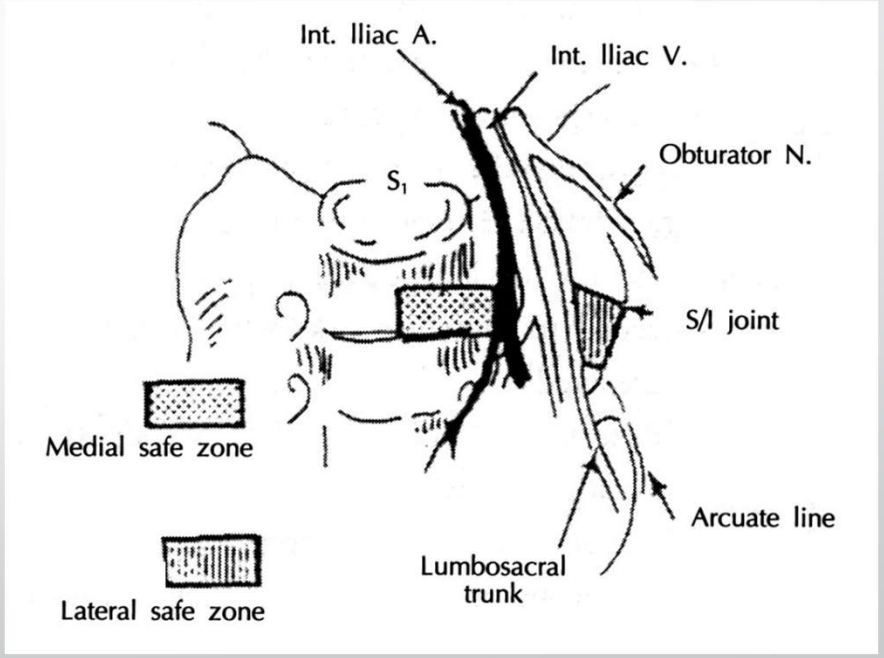
L5 Root Injury

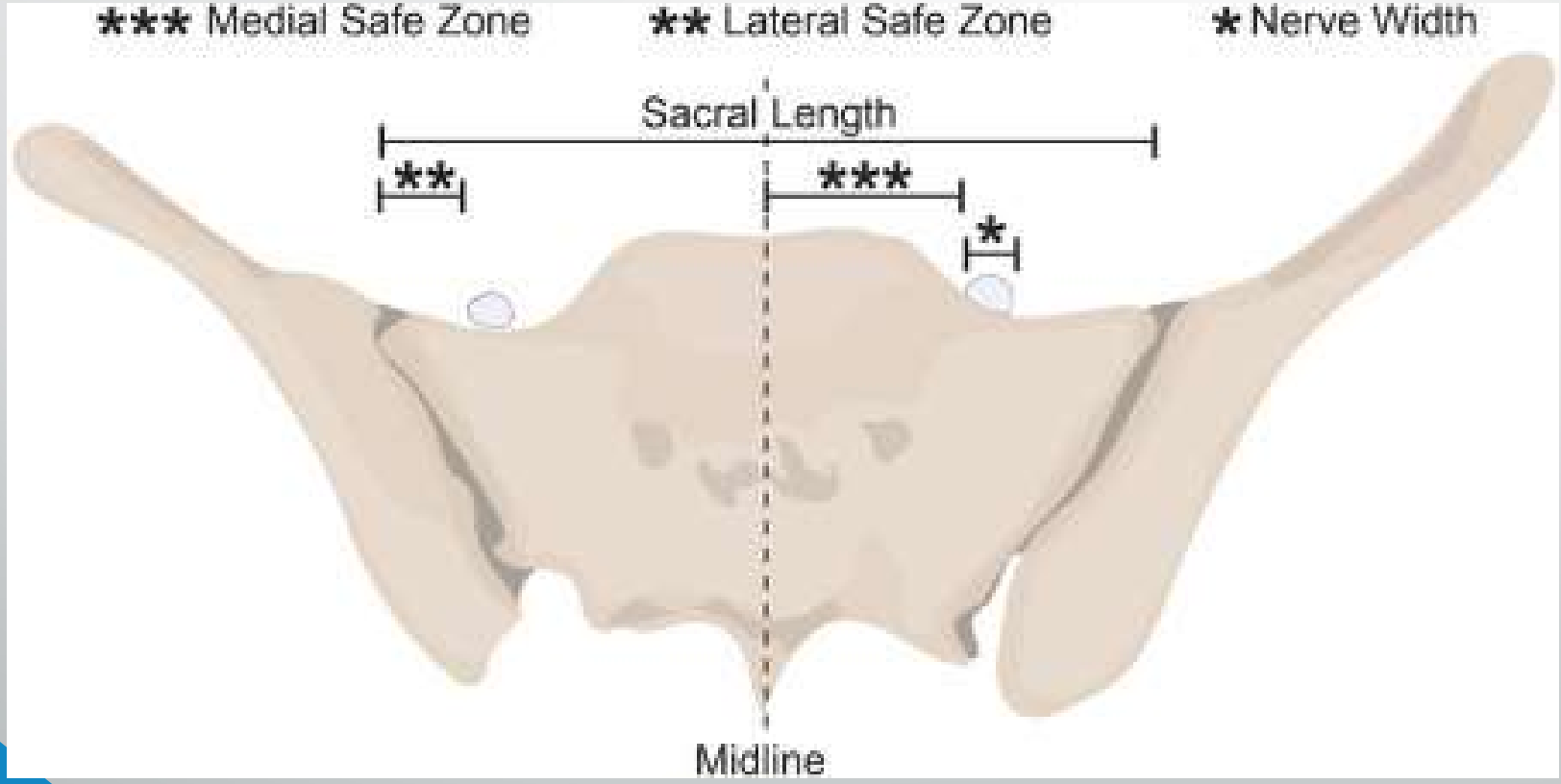
The right S1 screw was inserted outwardly and
penetrated 8.6 mm distant from the anterior cortex of the sacrum.
The right L5 nerve root is crushed between the pedicle screw and the lateral side of the S1 endplate



Mirkovic Safe Zones

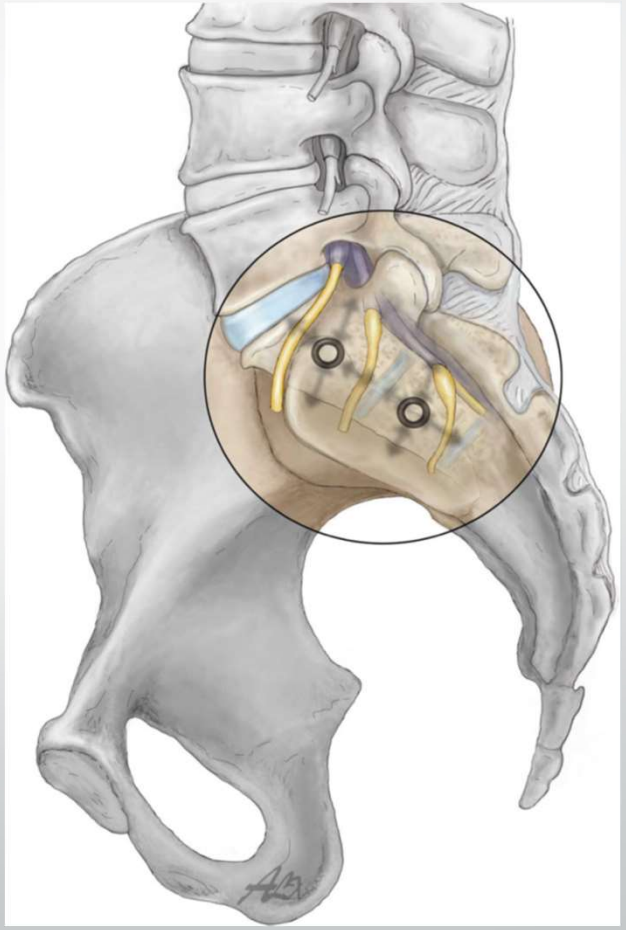
- Mirkovic, et al showed that with screws aimed 45 deg laterally into the sacral ala, 55% abutted the lumbosacral trunk and 8% contacted the internal iliac vein.
- He determined two safe zones.
- The medial safe zone (larger) lies between the sacral promontory medially and internal iliac vein laterally.
- The lateral safe zone is bordered laterally by the sacroiliac joint and medially by the lumbosacral trunk.




*** Medial Safe Zone
** Lateral Safe Zone
* Nerve Width
Sacral Length
**
***
*
Midline

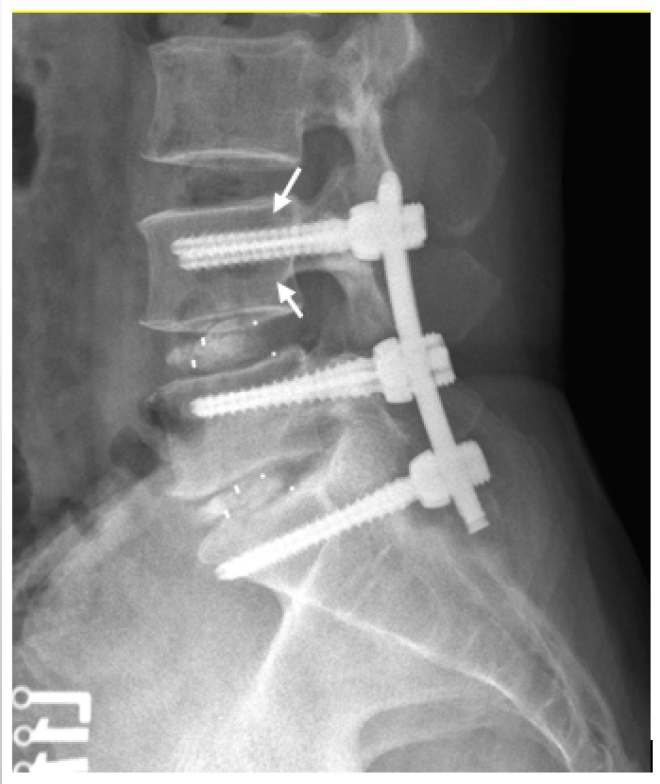
S1 injury Avoidance

- Esses, et al. stressed the need to evaluate the position of the sacral foramen and recommended placing screws above the S1 sacral foramen level directed medially toward the sacral promontory.



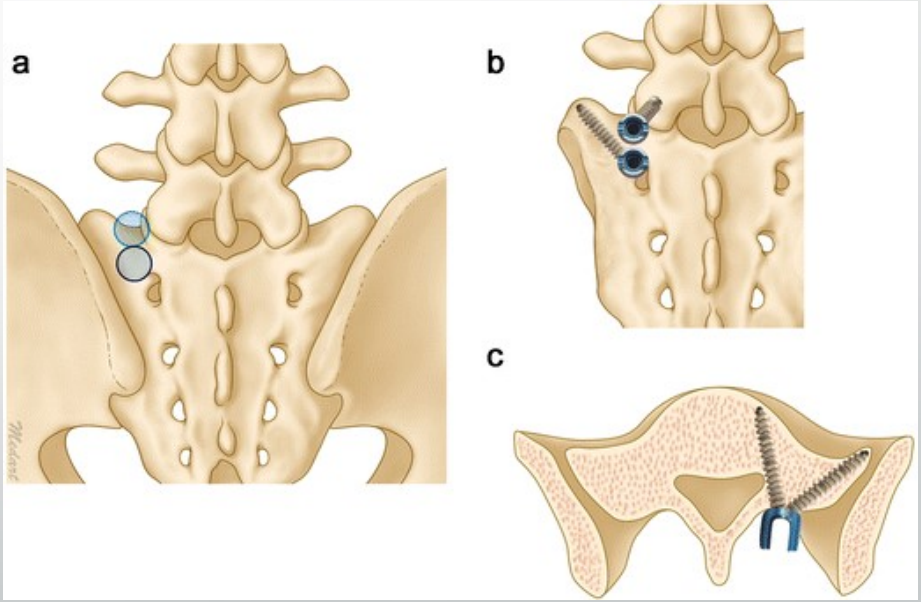
How Deep?

- Although bicortical purchase across the anterior sacral cortex is biomechanically stronger than unicortical purchase.
- Zindrick, found no statiscal difference in pullout strength between screws placed to a 50% depth and screws placed just up to but not penetrating the anterior cortex.
- Smith, demonstrated unicortical and bicortical screw fixations of sacrum sustained similar strength in older population.
- Licht, recommended that anterior cortical penetration not be used during pedicle screw fixation of the sacrum due to the lack of documented benefit of enhanced stability and the well defined risks to the sacral structures.



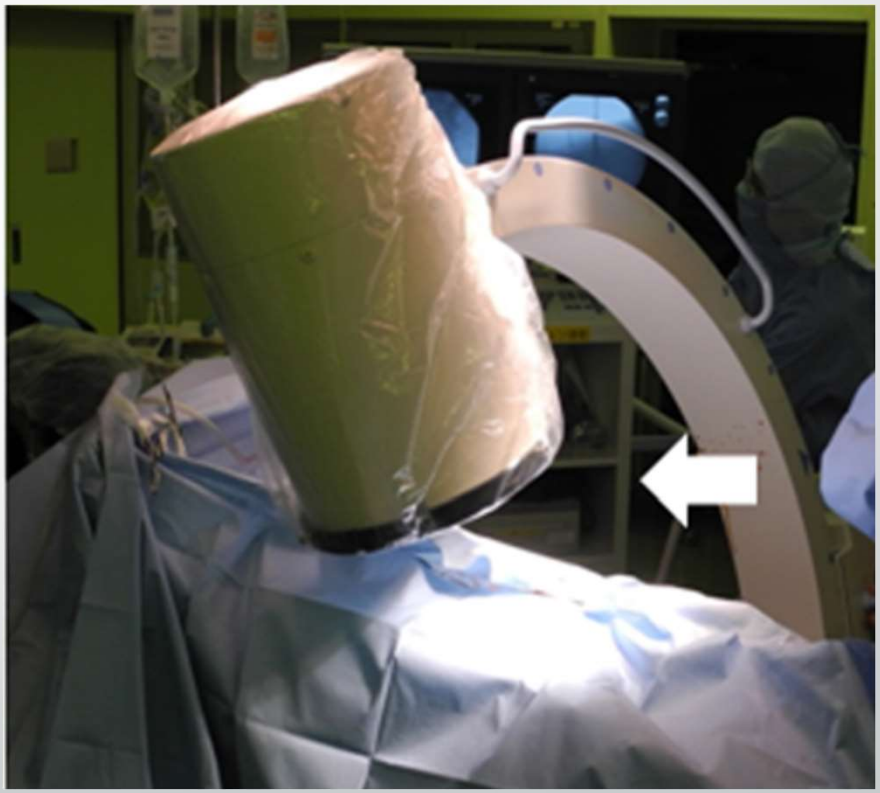
Medial vs Lateral

- There is general agreement that medially-directed screws are significantly stronger and carry minimal risk of injury than laterally-directed ones.



Fluoroscopic View

- Lat roentgenogram or fluoroscopic technique commonly used intraoperatively was inaccurate for determining actual penetration of anterior cortex by the screw because there are blind spots on cylindrical vertebral body.



Take Home Message

- Awareness of the detailed anterior sacral anatomy.
- Anatomical safe zones for sacral screw placement.
- Medial screw orientation into the sacral promontory.
- Avoidance of bicortical screw purchase across the anterior sacral cortex.
- The use of individualized preoperative CT scan for determining safe trajectory angle and screw depth.


Thank
You