Morphometric analysis of Cervical 1 and 2

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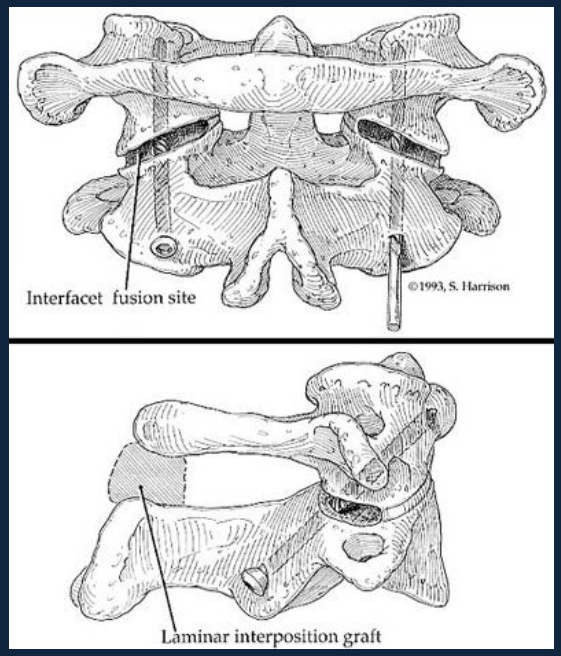
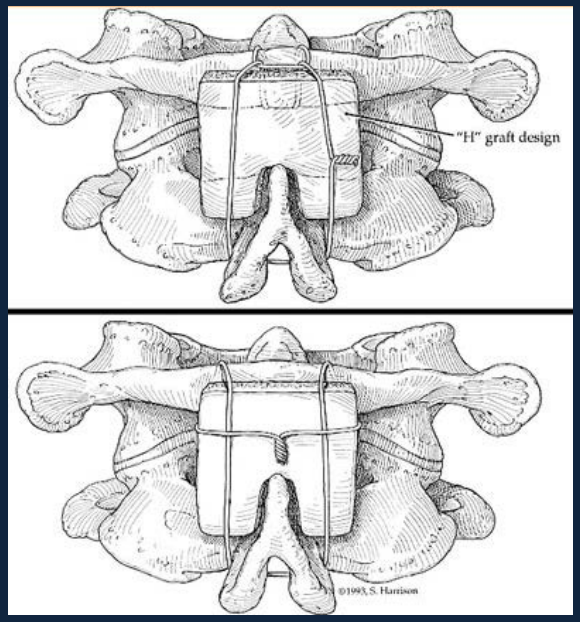
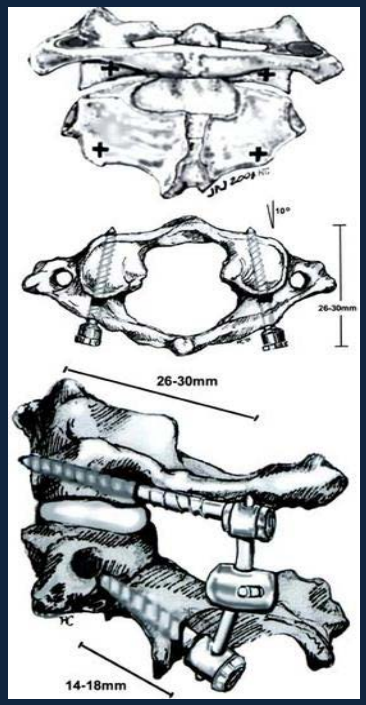
Background

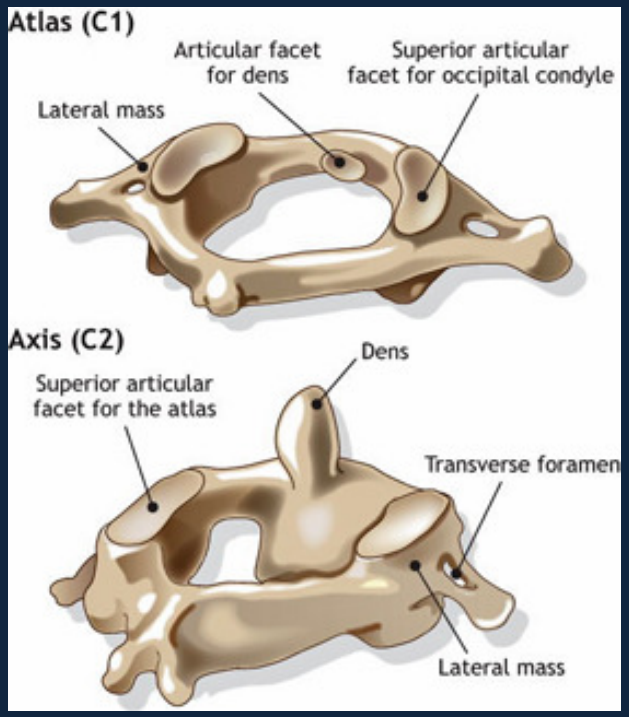
Stabilization of the atlantoaxial complex can be daunting due the complex and variable anatomy in this region.

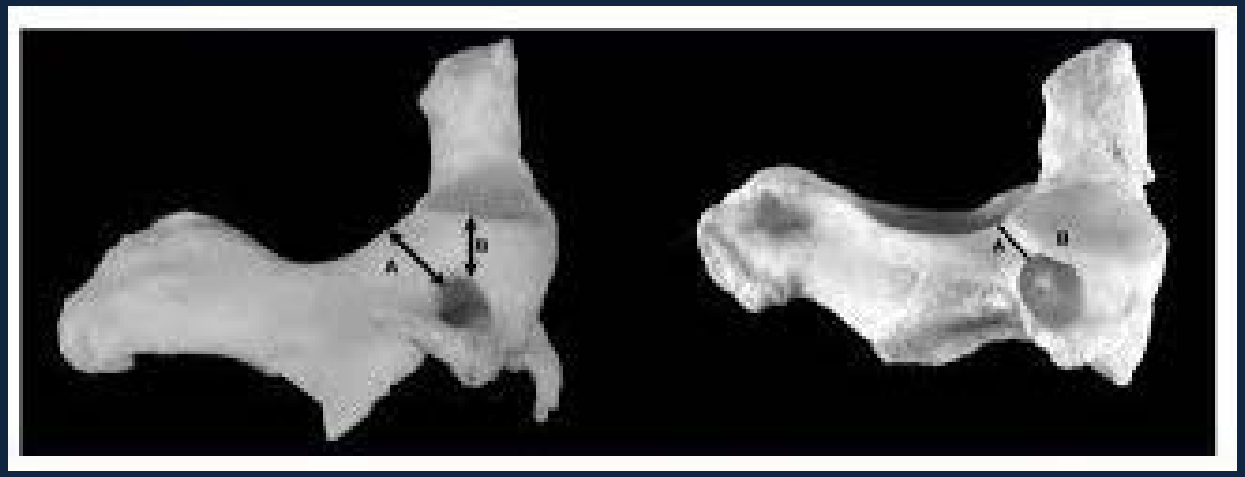
Posterior fixation across the atlantoaxial include transarticular screw fixation, wiring techniques, and lateral mass – pedicle fixation.

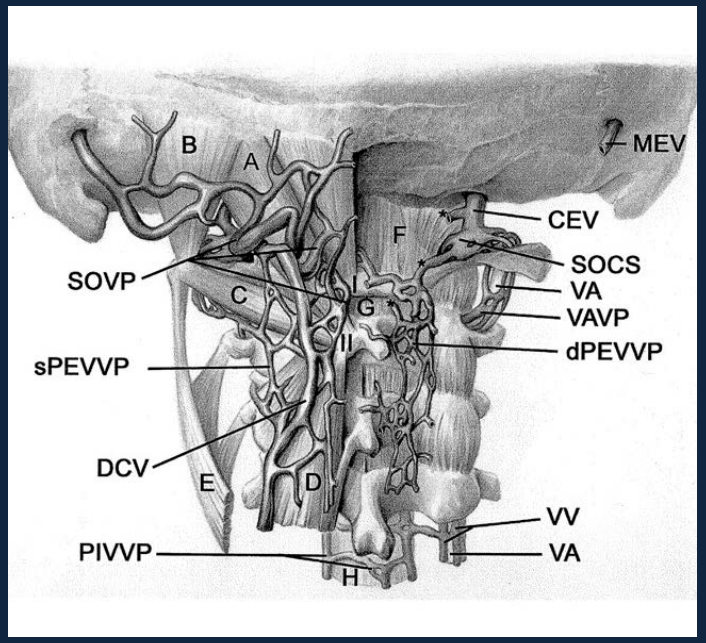


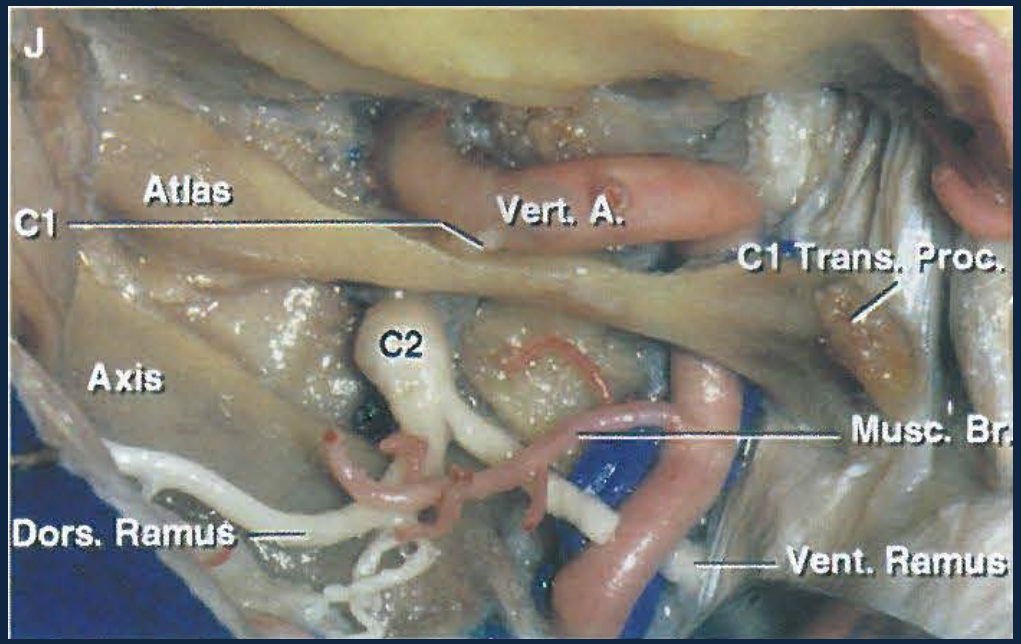





Atlas (C1)
Articular facet for dens
Superior articular facet for occipital condyle
Lateral mass
Axis (C2)
Dens
Superior articular facet for the atlas
Transverse foramen
Lateral mass




MEV
B
A
CEV
F
SOVP
SOCS
C
G
VA
VAVP
dPEVVP
sPEVVP
DCV
E
D
VV
PIVVP
VA
H


J
Atlas
C1
Vert. A.
C1 Trans. Proc.
C2
Axis
Musc. Br.
Dors. Ramus
Vent. Ramus

The following morphometric study characterizes morphometry of the cervical 1 and 2 bone as measured on CT scan in adults per IRB approval at GHSU.

134 serial CTs of cervical spine were obtained; fractures or mass lesions across the atlantoaxial regions were excluded from the study. All measurements were calibrated by the department of radiology at GHSU.

This study demonstrates the considerable anatomical variance between patients with attention to the size of the C1 lateral mass, diameter of C1 ring, and relationship between the transverse foramina and C2 pedicle.

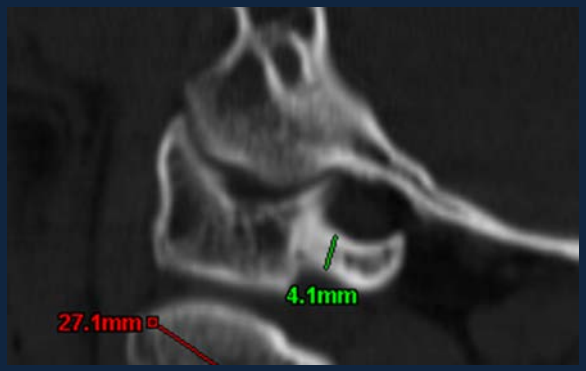
134 consecutive CT spine studies without fracture across the atlantoaxial junction were assessed between 17 and 79 years of age.

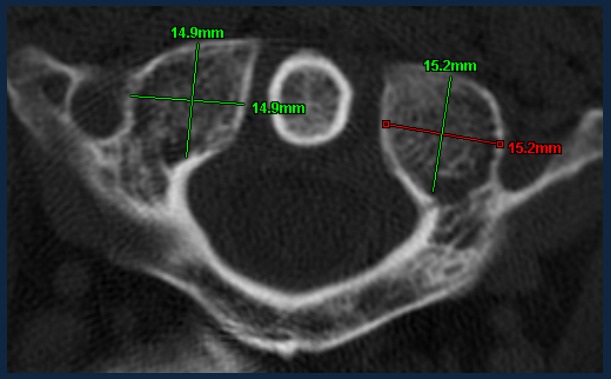
Mean age of 49 w/ stdev of 13yrs with 68 males and 66 females

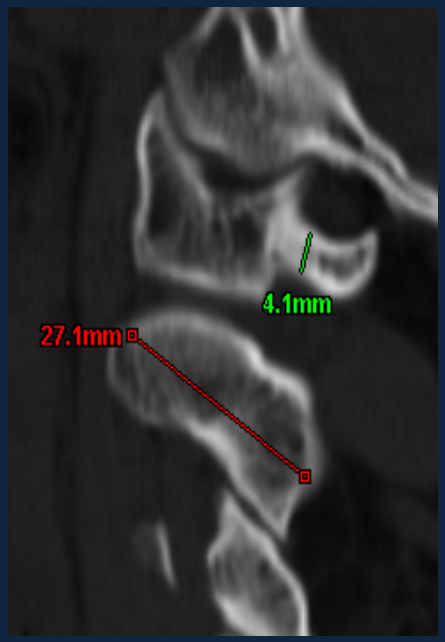
We measured AP/Lateral dimensions of the C1 lateral mass

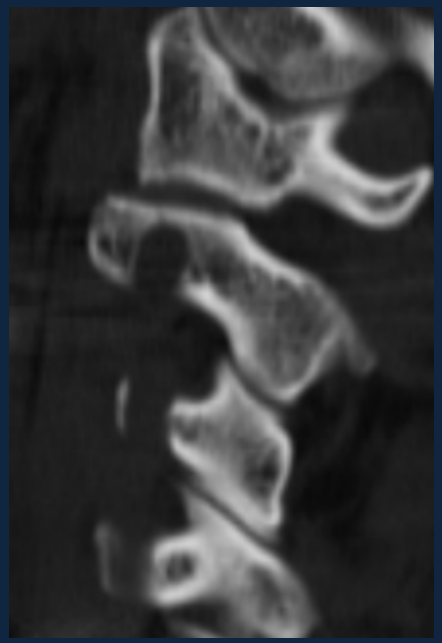
We measured minimal diameter of C1 ring

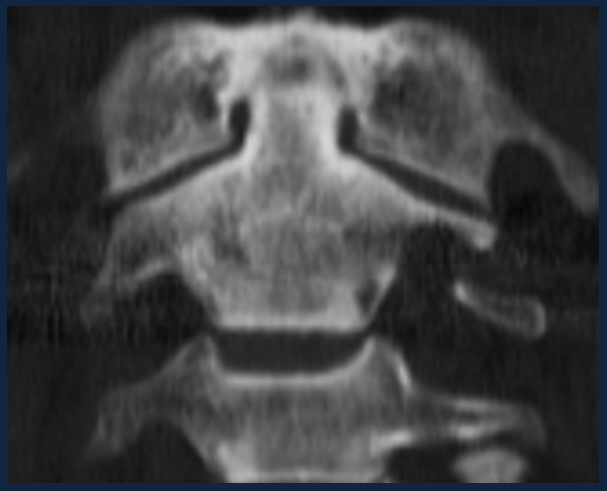
We assessed whether the transverse foramina could be visualized in a parasagittal image at the level of the lateral mass

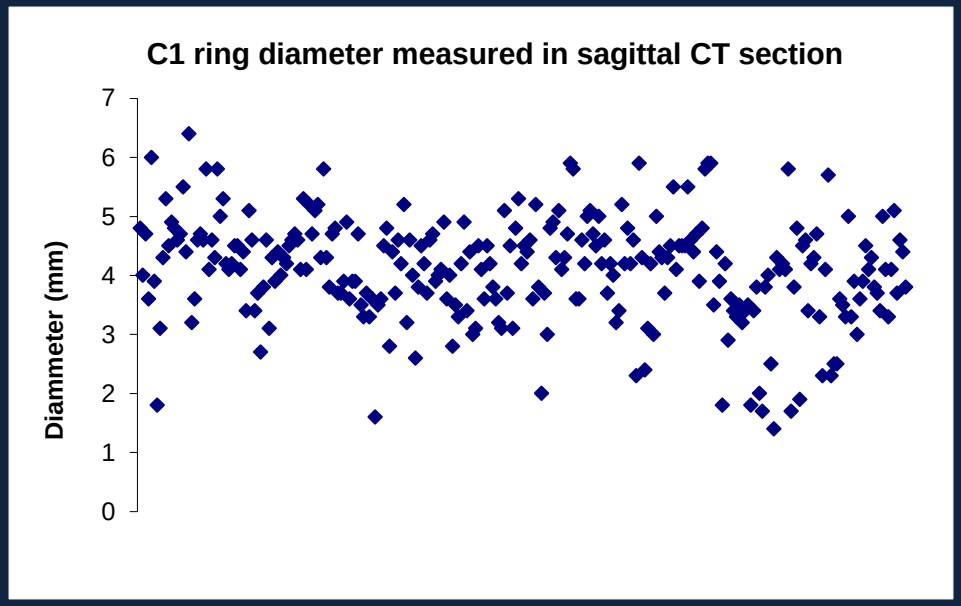


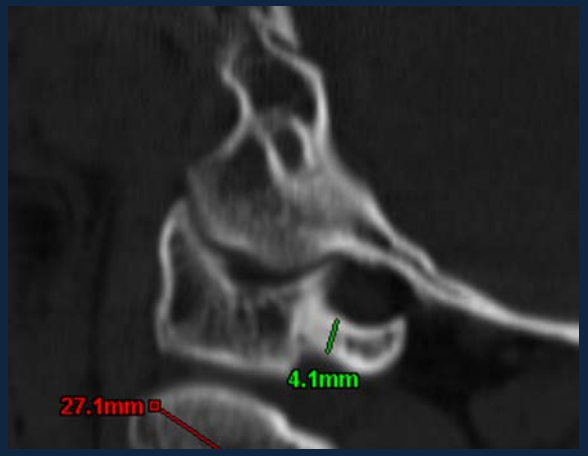






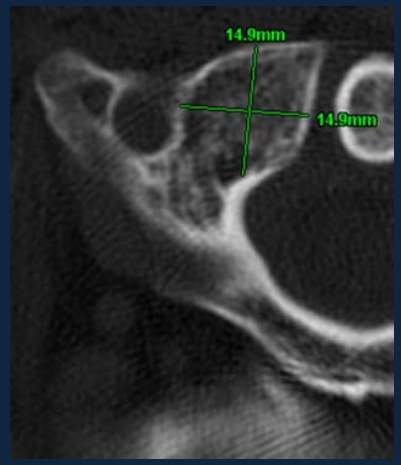


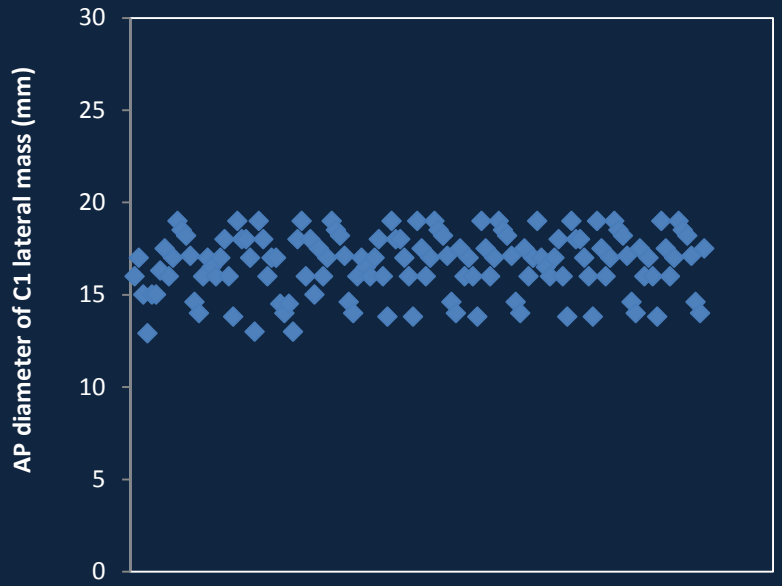


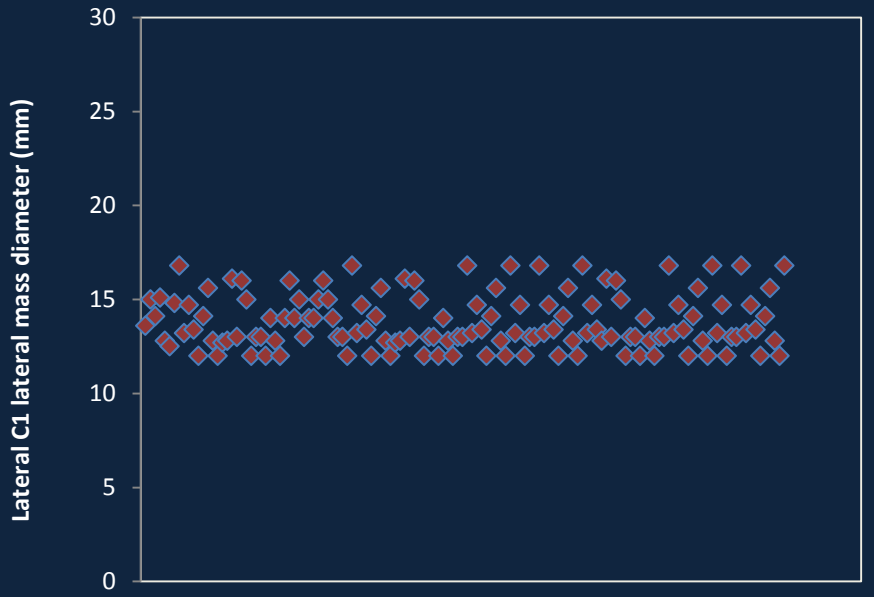


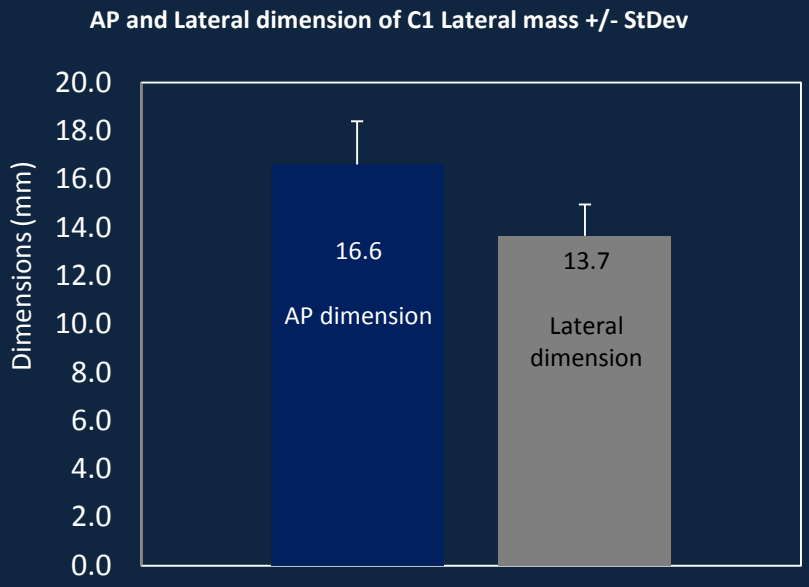
48 % of data points fall below 3.5 mm that coincidentally represents the minimal diameter allowable by current polyaxial screw fixation. Instrumentation of the C1 lateral mass should be performed in the cephalad and medial trajectory. Given considerable variability of the C1 ring, caution should be used in instrumentation starting on the ring itself.

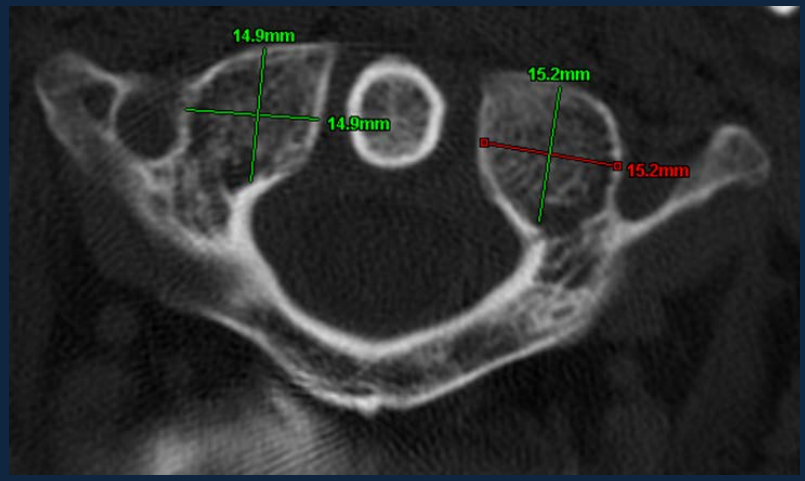
Vertebral artery lies laterally; thecal sac medially;
occipital condyles cephalad; and C2 nerve root caudally




AP diameter of C1 lateral mass (mm)
30
25
20
15
10
5
0


Lateral C1 lateral mass diameter (mm)
30
25
20
15
10
5
0

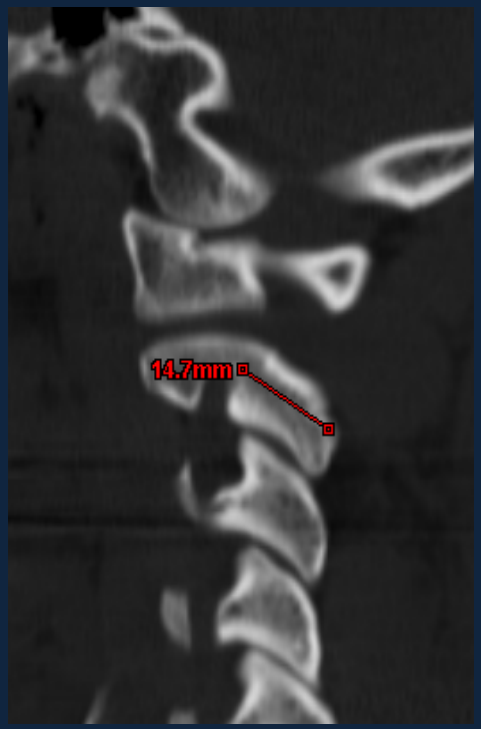

AP and Lateral dimension of C1 Lateral mass +/- StDev
Dimensions (mm)
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
16.6
AP dimension
13.7
Lateral dimension

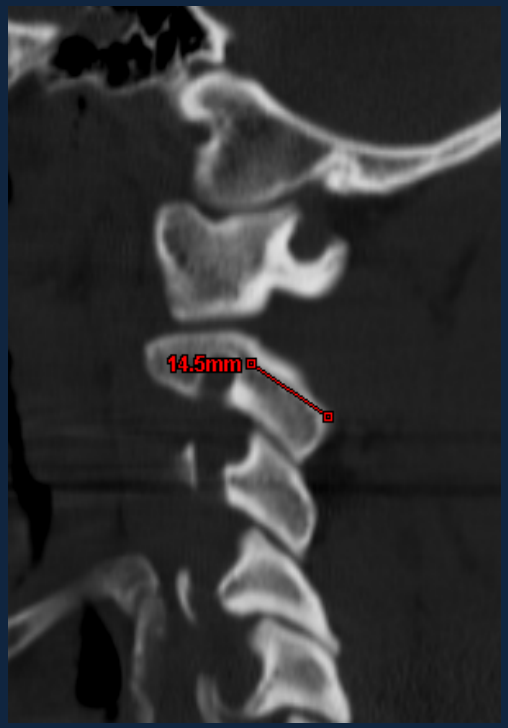

14.9mm
14.9mm
15.2mm
15.2mm

Example of vertebral artery through the transverse foramina of C2 that would favor screw placement

77 out of 134 patient measurements (61 %) of population fell into this category

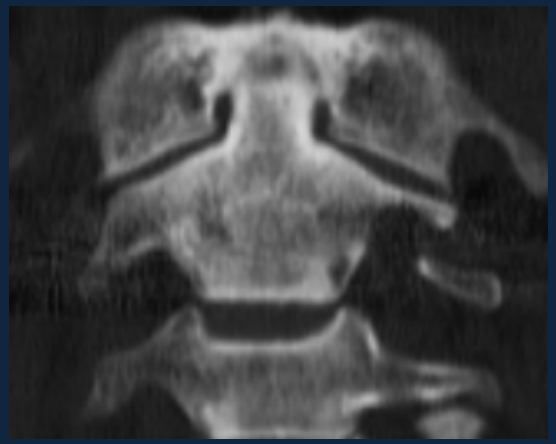
Example of high riding vertebral artery through the transverse foramina of C2 that would influence screw placement on both sides

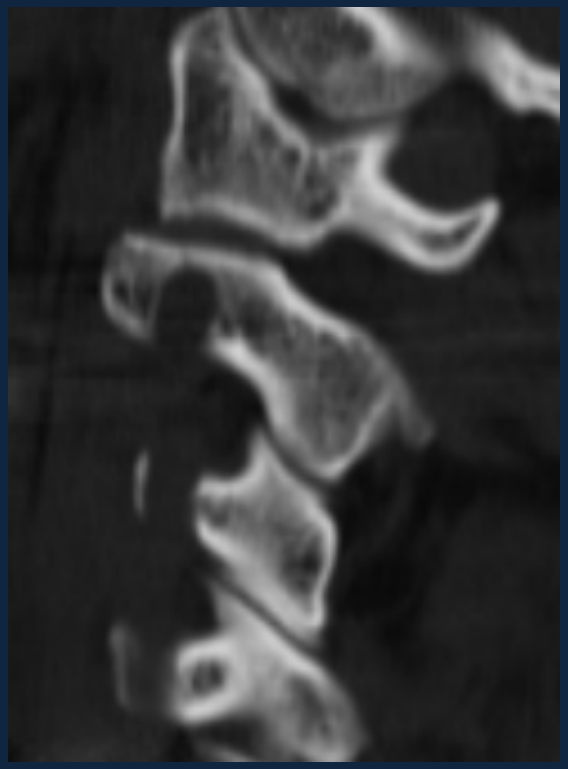




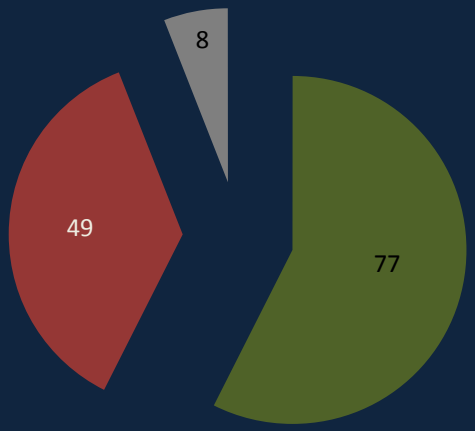
8 out of 134 patient measurements (6 %) of population fell into this category

Example of high riding vertebral artery through the transverse foramina of C2 that would influence screw placement on 1 side only

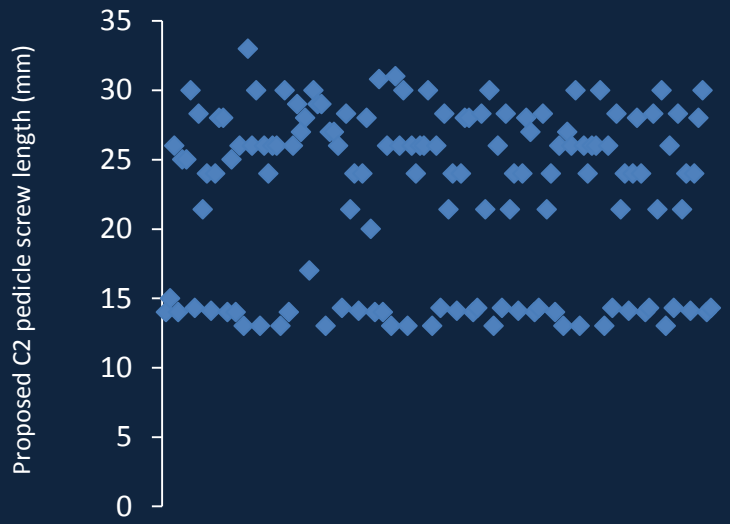




49 out of 134 patient measurements (34 %) of population fell into this category



Of the 134 studies evaluated, 61% (77/134) represents C2 anatomy favorable for segmental fixation; 34% (49/134) represents a high riding vertebral artery on one side and 6% (8/134) where high riding vertebral artery is seen on both sides



Scatter plot of proposed C2 instrumentation length recapitulated the result that a significant percentage of C2 anatomy has a high riding vertebral artery. Curiously out of 268 data points ascertained, no values less than 12 mm were measured.

Summary

Considerable variability exists in C1 ring dimensions, however the C1 lateral mass is considerably more consistent.

The trajectory of the vertebral artery through C2 is variable and may influence the length of C2 pedicle screw placement; knowledge of where the vertebral artery traverses is essential before screw placement