ORIGINAL RESEARCH

The Use of Peritrope Radiographs as a Biomechanical Method for Determining Atlas–Axis Subluxation Listings

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ABSTRACT

Background: Knee Chest Specific Chiropractic technique has pioneered a new radiographic image, called the KCSC Peritrope X-ray, for analyzing atlas and axis subluxation listings. This novel approach uses the principles of spinal biomechanics to visualize which joint is locked out of its normal range of motion.

Methods: The KCSC Peritrope X-ray images the cervical spine in maximal cervical rotation, with the patient facing the bucky for atlas subluxation listings that begin with AS (anterior-superior), and the patient facing the X-ray tube for atlas subluxation listings that begin with PI (posterior-inferior). This analysis focuses on joint biomechanics between the occipital condyles and atlas lateral masses, as well as between axis inferior facets and C3 superior facets. Specific points of analysis are used to compare joint biomechanics between the respective segments. A subluxation listing is then ascribed to the vertebra demonstrating abnormal joint biomechanics.

Conclusion: The KCSC Peritrope X-ray represents a new development in the field of chiropractic radiographic analysis for atlas and axis subluxation listings. In addition to the traditional static X-ray series taken of the cervical spine, the KCSC Peritrope X-ray provides a new biomechanical approach which determines the major subluxation and its specific listing. Using this biomechanical analysis, a new biomechanical finding for the craniocervical joint was discovered that has never been described before in the literature.

Keywords: *Biomechanics, Peritrope X-ray, knee chest specific chiropractic, vertebral subluxation, adjustment*

Introduction

Historical Considerations on Radiographic Analysis for Subluxation Listings

The Palmer School of Chiropractic was credited with taking the first spinal X-rays for the analysis of vertebral subluxations in 1910.[1] The purpose of the spinal X-ray was to overcome two major variables in the analysis of vertebral subluxations: 1) interexaminer reliability in palpating vertebral misalignments and 2) osseous malformations that can cause erroneous subluxation listings.

Prior to X-ray, the preferred method for analyzing vertebral subluxations was static palpation. This method would have the chiropractor palpate each vertebra in the spinal column using the spinous process as the reference point for segments axis and below and using the transverse processes of atlas as reference points for this segment alone.

For segments C2 and below, a positive finding of subluxation at the segment level would reveal that the spinous process of

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one vertebra was displaced laterally when compared to the vertebra above and/or below, as viewed on an AP X-ray.

For atlas, a positive finding of subluxation would reveal one transverse process being more superior in relation to the contralateral transverse process, as viewed on an APOM X-ray.

Static palpation required a great deal of training to feel for vertebral displacements, often being slight in character. However, even with training, static palpation was again limited by osseous malformations which could present as false-positive subluxations.

A common osseous malformation described by BJ Palmer was a malformed spinous process.[2] Normal vertebral structures will have the laminae grow proportionally to each other, creating a spinous process that extends posteriorly to the vertebral body. In cases of osseous malformations, one lamina may be hypertrophied in relation to the contralateral lamina.

This would produce a spinous process that does not extend directly posterior to the vertebral body. Instead, the spinous process would be either left or right of midline in its natural position. However, upon static palpation, the spinous process would feel as if it had lateralized when compared to adjacent segments, therefore, creating a false-positive subluxation listing at that segment.

Spinal X-rays eliminated the variables of interexaminer reliability and osseous malformations. Chiropractors could now see objectively what they were feeling subjectively.

Using spinal X-rays, Palmer taught the following as indicators for a subluxation: For atlas, one transverse process would be more superior than the contralateral transverse process on the APOM view. For segments C2 and below, chiropractors would analyze for any lateral tilting of the vertebra or spinous process rotation away from midline.[2]

Description of Normal Upper Cervical Biomechanics Upon Rotation

The following normal biomechanics of the upper cervical spine upon maximal cervical rotation were first described in the KCSC research paper published in July of 2024.[3] At the time, the KCSC Peritrope X-ray had not been officially named and was referred to as "cervical rotation views".

Etymology for the Peritrope X-ray is rooted in ancient Greek. It refers to "a turning around". It was thus named because this X-ray images the cervical spine in maximal rotation. The credit for naming this new X-ray has been attributed to KCSC instructor, Dr. Scott Jackson.

Atlas lateral masses are compared to their respective occipital condyles.

Upon left cervical rotation, atlas left lateral mass demonstrates normal biomechanics when it moves down the left occipital condyle in a posterior-inferior direction. The reference points to analyze this biomechanic are as follows: occipital condyle- superior, anterior tip; atlas lateral mass- superior, anterior tip.

Upon right cervical rotation, atlas right lateral mass demonstrates normal biomechanics when it moves down the right occipital condyle in a posterior-inferior direction. The reference points to analyze this biomechanic are as follows: occipital condyle- superior, anterior tip; atlas lateral mass- superior, anterior tip.

This motion of atlas lateral mass moving posterior-inferior upon its respective occipital condyle upon cervical rotation, when viewed in the sagittal plane, is a new discovery in the field of upper cervical biomechanics. Regarding cervical rotation, the only biomechanical motion to have been previously described involves rotation of atlas lateral masses upon their respective occipital condyles when viewed in the transverse plane.[4]

Axis inferior facets are compared to their respective C3 superior facets.

Upon left cervical rotation, axis will pivot upon the left C2/C3 facet joint, as the right C2 inferior facet moves anterior-superior upon the right C3 superior facet. This causes axis spinous process to rotate towards the right beyond C3 spinous process.

Upon right cervical rotation, axis will pivot upon the right C2/C3 facet joint, as the left C2 inferior facet moves anterior-superior upon the left C3 superior facet. This causes axis spinous process to rotate towards the left beyond C3 spinous process.

Methods

The KCSC Peritrope X-ray uses two perspectives to evaluate atlas subluxation listings: one for AS (anterior-superior) listings, and one for PI (posterior-inferior) listings. For atlas subluxation listings that begin with AS, the patient will stand facing the bucky. The patient is asked to maximally rotate the cervical spine to each side for exposure. The central ray will be focused on the mastoid fossa. The mastoid fossa is that area of soft tissue that can be found directly inferior to the tip of the mastoid process.

For left cervical rotation, the KCSC Peritrope X-ray will reveal the left atlanto-occipital joint and the left bifurcation of C2 and C3 spinous processes.

For right cervical rotation, the KCSC Peritrope X-ray will reveal the right atlanto-occipital joint and left bifurcation of C2 and C3 spinous processes.

X-ray console factors for the KCSC Peritrope X-ray will be the same as the lateral view for each specific patient.

The points of analysis are as follows:

- Atlas lateral mass: anterior-superior tip.
- Occipital condyle: anterior-superior tip.
- C2 spinous process: bifurcation on the side of cervical rotation.
- C3 spinous process: bifurcation of the side of cervical rotation.

For atlas subluxation listings that start with PI, the patient will stand facing the X-ray tube. The patient is then asked to maximally rotate their cervical spine to each side for exposure. The central ray will be focused on the mastoid fossa.

For left cervical rotation, the KCSC Peritrope X-ray will reveal the right atlanto-occipital joint.

For right cervical rotation, the KCSC Peritrope X-ray will reveal the left atlanto-occipital joint.

X-ray console factors for the KCSC Peritrope X-ray will be the same as the lateral view for each specific patient.

The points of analysis are as follows:

- Atlas lateral mass: anterior-superior tip.
- Occipital condyle: anterior-superior tip.

Description of Subluxation Upper Cervical Biomechanics Upon Rotation

According to BJ Palmer, when a subluxation occurs at the level of atlas or axis, it will demonstrate five characteristics:[2]

1. Misalignment: displacement of one vertebra in relation to the segments above and/or below.
2. Occlusion: narrowing of opening where spinal nerves pass through.
3. Pressure: vertebral pressure upon the spinal cord and/or spinal nerves.
4. Interference: decreased quantity transmission of nerve flow from brain to body.
5. Permanency: the subluxated vertebra is locked out of its normal range of motion.

The KCSC Peritrope X-ray tests the following subluxation characteristics: misalignment, occlusion, and permanency using a biomechanical analysis. The purpose is to attain a subluxation listing of either atlas or axis. This is then used to determine the direction of the adjustic thrust used to unlock the vertebra, which reduces the misalignment, occlusion, pressure, interference, and permanent characteristics of vertebral subluxation.

Atlas Biomechanical Analysis (ASL and ASR listings):

For atlas subluxation listings ASL, atlas left lateral mass will be subluxated (locked) anterior-superior and lateralize left against the left occipital condyle. Upon left cervical rotation, atlas left lateral mass will not move posterior-inferior upon the left occipital condyle or will do so to a lesser extent than the contralateral lateral mass. Using the reference points previously mentioned, atlas left lateral mass (anterior-superior point) will not appear to move away from the left occipital condyle (anterior-superior point) or to a lesser extent than the contralateral lateral mass.

For atlas subluxation listings ASR, atlas right lateral mass will be subluxated (locked) anterior-superior and lateralize right against the right occipital condyle. Upon right cervical rotation, atlas right lateral mass will not move posterior-inferior upon the right occipital condyle or will do so to a lesser extent than the contralateral lateral mass. Using the reference points previously mentioned, atlas right lateral mass (anterior-superior point) will not appear to move away from the right occipital condyle (anterior-superior point) or to a lesser extent than the contralateral lateral mass.

Axis Biomechanical Analysis (PLI and PRI listings):

For axis subluxation listings PLI, axis right inferior facet will be subluxated (locked) posterior-inferior and lateralize left, against C3 right superior facet. Upon left cervical rotation, axis right inferior facet will not move anterior-superior upon C3 right superior facet, preventing axis spinous process from rotating right, beyond C3 spinous process, or to a lesser extent than the contralateral side.

For axis subluxation listings PRI, axis left inferior facet will be subluxated (locked) posterior-inferior and lateralize right, against C3 left superior facet. Upon right cervical rotation, axis left inferior facet will not move anterior-superior upon C3 left superior facet, preventing axis spinous process from rotating left, beyond C3 spinous process, or to a lesser extent than the contralateral side.

Atlas Biomechanical Analysis for PI Listings:

Atlas subluxation listings beginning with PI indicates that the atlas lateral mass is subluxated posterior-inferior upon its respective occipital condyle. This can be visualized using the KCSC Peritrope X-ray taken from the opposite position as that for atlas AS subluxation listings. For atlas PI subluxation listings, the patient will face the X-ray tube and maximally rotate the cervical spine exposing each side.

Regarding atlas subluxation listing PIL, atlas left lateral mass has subluxated posterior-inferior and lateralized towards the left, against the left occipital condyle.

Upon right cervical rotation, an atlas PIL subluxation will not move anterior-superior upon the left occipital condyle, or to a lesser extent than the opposite side.

Regarding the atlas subluxation listing PIR, atlas right lateral mass has subluxated posterior-inferior and lateralized towards the right, against the right occipital condyle.

Upon left cervical rotation, an atlas PIR subluxation will not move anterior-superior upon the right condyle, or to a lesser extent than the opposite side.

Radiographic Examples

Figure 1a images the cervical spine in left maximal cervical rotation with the patient facing the bucky. The structures viewed are the left occipital condyle, left atlas lateral mass and the spinous processes of axis and C3.

Figure 1b is the same as Figure 1a, marked for visual clarity. Atlas left lateral mass is not moving posterior-inferior upon the left occipital condyle, demonstrating abnormal biomechanics and indicating a subluxation of atlas ASL. This is not an axis subluxation, as axis spinous process is demonstrating normal biomechanics by rotating right, beyond

C3 spinous process.

Figure 1c images the cervical spine in right maximal cervical rotation with the patient facing the bucky. The structures viewed are the right occipital condyle, right atlas lateral mass and the spinous processes of axis and C3.

Figure 1d is the same as Figure 1c, marked for visual clarity. Atlas right lateral mass is moving posterior-inferior upon the right occipital condyle, demonstrating normal biomechanics. This is not an axis subluxation, as axis spinous process is demonstrating normal biomechanics by rotating left, beyond C3 spinous process.

Figure 2a images the cervical spine in left maximal cervical rotation with the patient facing the X-ray tube. The structures viewed are the right occipital condyle and atlas right lateral mass. Axis is omitted from analysis on this specific view, as according to BJ Palmer, axis cannot subluxate anterior-superior due to the bony lock between the odontoid process of axis and the fovea dentalis of atlas.[2]

Figure 2b is the same as Figure 2a, marked for visual clarity. Atlas right lateral mass is moving in an anterior-superior direction upon the right occipital condyle, demonstrating normal biomechanics.

Figure 2c images the cervical spine in right maximal cervical rotation with the patient facing the X-ray tube. The structures viewed are the left occipital condyle and atlas left lateral mass. Axis is omitted from analysis on this specific view, as according to BJ Palmer, axis cannot subluxate anterior-superior due to the bony lock between the odontoid process of axis and the fovea dentalis of atlas.[2]

Figure 2d is the same as Figure 2c, marked for visual clarity. Atlas left lateral mass is not moving anterior-superior upon the left occipital condyle, demonstrating abnormal biomechanics and indicating an atlas subluxation PIL.

Figure 3a images the cervical spine in left maximal cervical rotation with the patient facing the bucky. The structures viewed are C2 and C3 spinous processes.

Figure 3b is the same as Figure 3a, marked for visual clarity. Axis spinous process is not rotating right, beyond C3 spinous process, demonstrating abnormal biomechanics and indicating an axis subluxation PLI. Notice how atlas left lateral mass is moving posterior-inferior upon the left occipital condyle, demonstrating normal biomechanics.

Figure 3c images the cervical spine in right maximal cervical rotation with the patient facing the bucky. The structures viewed are C2 and C3 spinous processes.

Figure 3d is the same as Figure 3c, marked for visual clarity. Axis spinous process is rotating left, beyond C3 spinous process, demonstrating normal biomechanics. Notice how atlas right lateral mass is moving posterior-inferior upon the right occipital condyle, demonstrating normal biomechanics.

Discussion

The KCSC Peritrope X-ray is a significant advancement in the radiographic analysis of atlas and axis subluxation listings. Using the principles of spinal biomechanics, chiropractors can objectively test and analyze the craniocervical joints and axis/C3 joints for abnormal biomechanics.

The craniocervical joints and axis/C3 joints are tested for normal biomechanics upon maximal cervical rotation bilaterally. The joint that demonstrates abnormal biomechanics upon maximal cervical rotation is considered the side of subluxation and is ascribed a subluxation listing (i.e. atlas ASL or axis PRI).

The benefits of using spinal biomechanics to analyze the upper cervical spine for subluxation listings, as visualized on the KCSC Peritrope X-ray are twofold.

First, it distinguishes between an atlas and an axis subluxation. There are cases where both atlas and axis appear to be displaced on X-ray. By testing the joints through maximal cervical rotation, one vertebra will demonstrate normal biomechanics while the other will not. The vertebra that is not demonstrating normal biomechanics is the subluxation, while the other vertebra has merely compensated in its structural alignment without causing nerve pressure and interference to quantity nerve flow.

Secondly, the limitations of traditional static X-ray analysis when dealing with osseous malformations can be overcome. Osseous malformations, such as a hypotrophied occipital condyle, alter the normal structural alignment between it and atlas lateral masses. This may cause the atlas to appear unlevel with the occipital condyles, yet still be in normal alignment and not considered subluxated. For traditional static X-ray analyses like “arc analysis”, “interodontoid space” and “measuring lateral atlas displacement”, osseous malformations often result in a false-positive subluxation listings, as these analyses assume osseous symmetry. However, when testing malformed joints through maximal cervical rotation, normal biomechanics and abnormal biomechanics can still be demonstrated, aiding the chiropractor in ascribing a subluxation to the specific vertebra in question.

References

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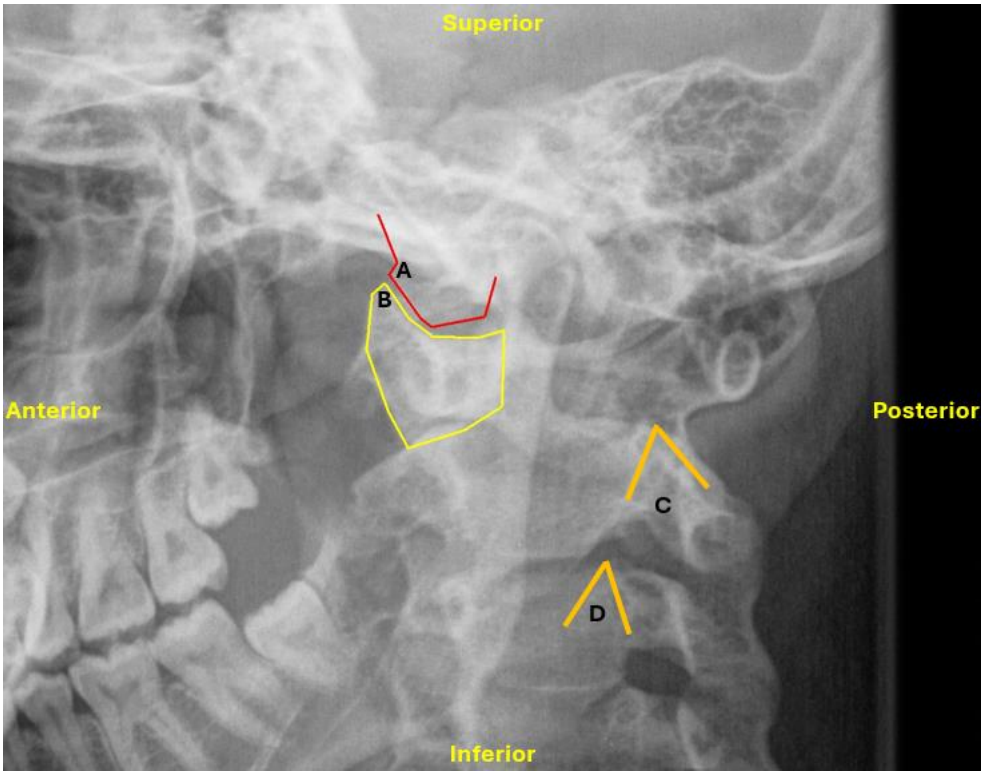
Appendix

KCSC Peritrope X-ray: Left Maximal Cervical Rotation (Atlas AS listings, Axis PI listings)

Figure 1a (unmarked); **Patient position:** facing bucky, left maximal cervical rotation; **Structures viewed:** left occipital condyle, left Atlas lateral mass, C2 and C3 spinous processes.

Figure 1b (marked); Patient position: facing bucky, left maximal cervical rotation; **Structures viewed:** left occipital condyle, left Atlas lateral mass, C2 and C3 spinous processes; **Points of analysis:** (A) occipital condyle (anterior-superior tip), (B) Atlas lateral mass (anterior-superior tip), (C) C2 spinous process. (D) C3 spinus process; **Subluxation listing:** Atlas ASL.



KCSC Peritrope X-ray: Right Maximal Cervical Rotation (Atlas AS listings, Axis PI listings)

Figure 1c (unmarked); Patient position: facing bucky, right maximal cervical rotation; **Structures viewed:** right occipital condyle, right Atlas lateral mass, right bifurcation of C2 and C3 spinous processes.

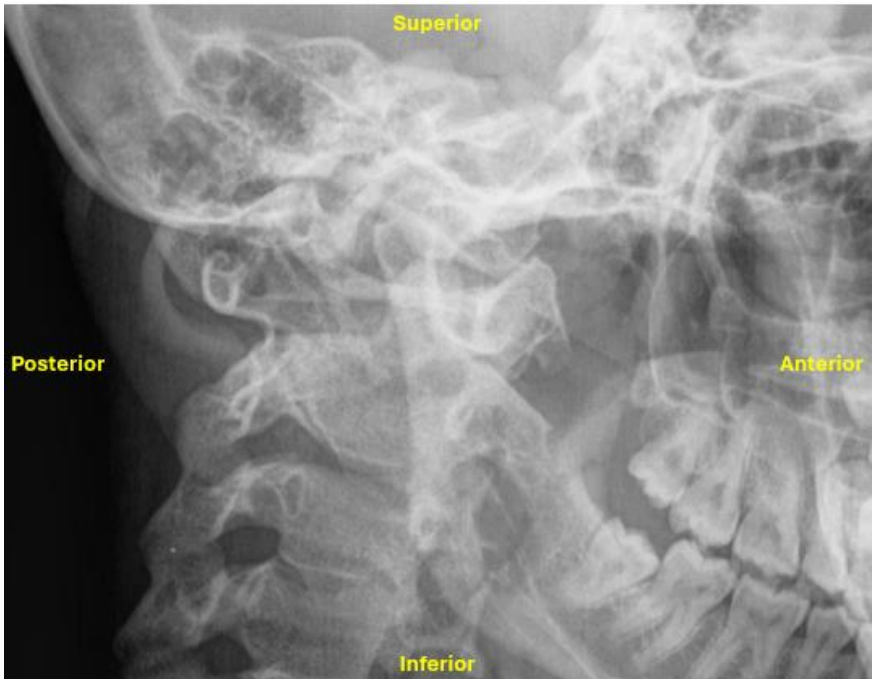
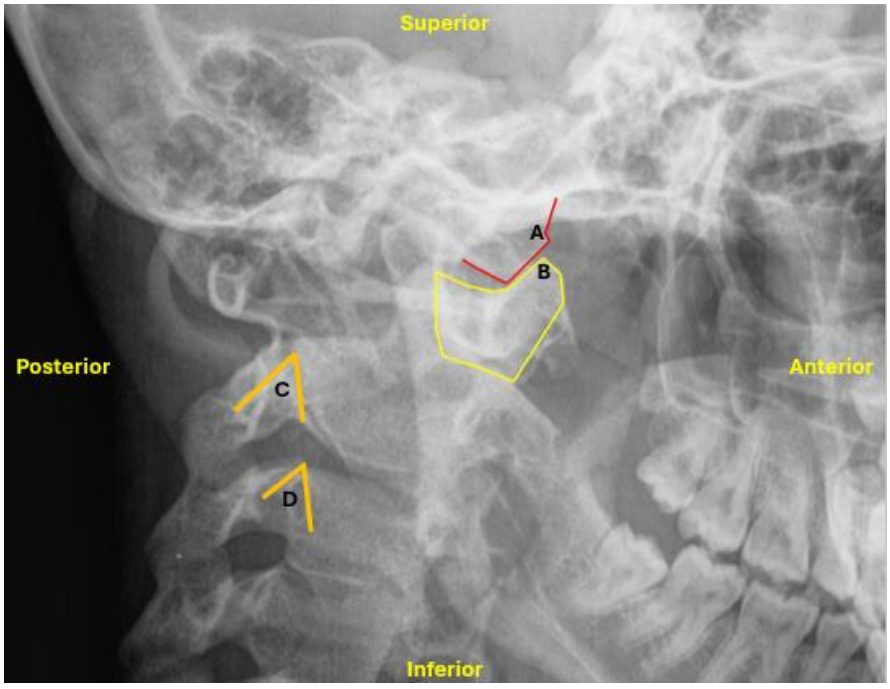


Figure 1d (marked); Patient position: facing bucky, right maximal cervical rotation; **Structures viewed:** right occipital condyle, right Atlas lateral mass, right bifurcation of C2 and C3 spinous processes; **Points of analysis:** (A) occipital condyle (anterior-superior tip), (B) Atlas lateral mass (anterior-superior tip), (C) C2 spinous process. (D) C3 spinus process.



KCSC Peritrope X-ray: Left Maximal Cervical Rotation (Atlas PI listings)

Figure 2a (unmarked); Patient position: facing X-ray tube, left maximal cervical rotation; **Structures viewed:** right occipital condyle, right Atlas lateral mass.

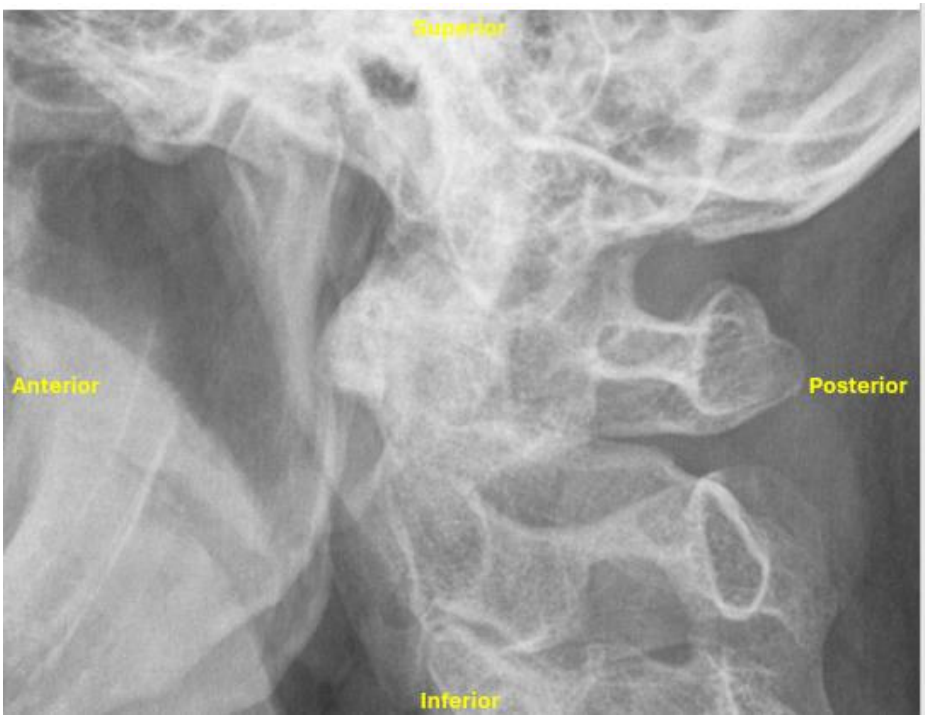
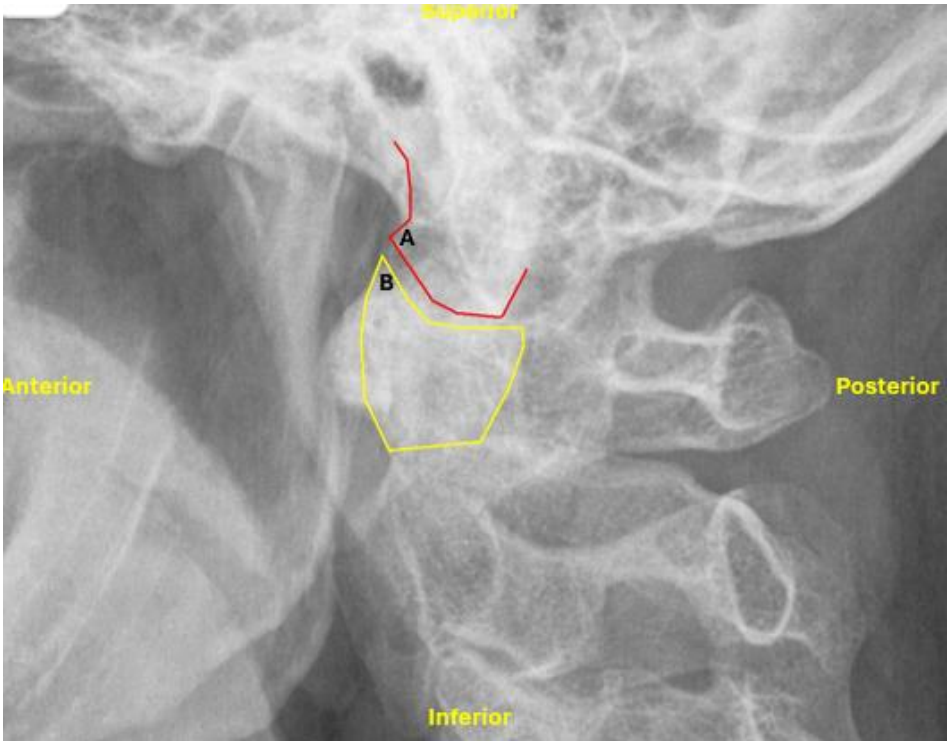


Figure 2b (marked); Patient position: facing X-ray tube, left maximal cervical rotation; **Structures viewed:** right occipital condyle, right Atlas lateral mass; **Points of analysis:** (A) occipital condyle (anterior-superior tip), (B) Atlas lateral mass (anterior-superior tip).



KCSC Peritrope X-ray: Right Maximal Cervical Rotation (Atlas PI listings)

Figure 2C (unmarked); Patient position: facing X-ray tube, right maximal cervical rotation; **Structures viewed:** left occipital condyle, left Atlas lateral mass.

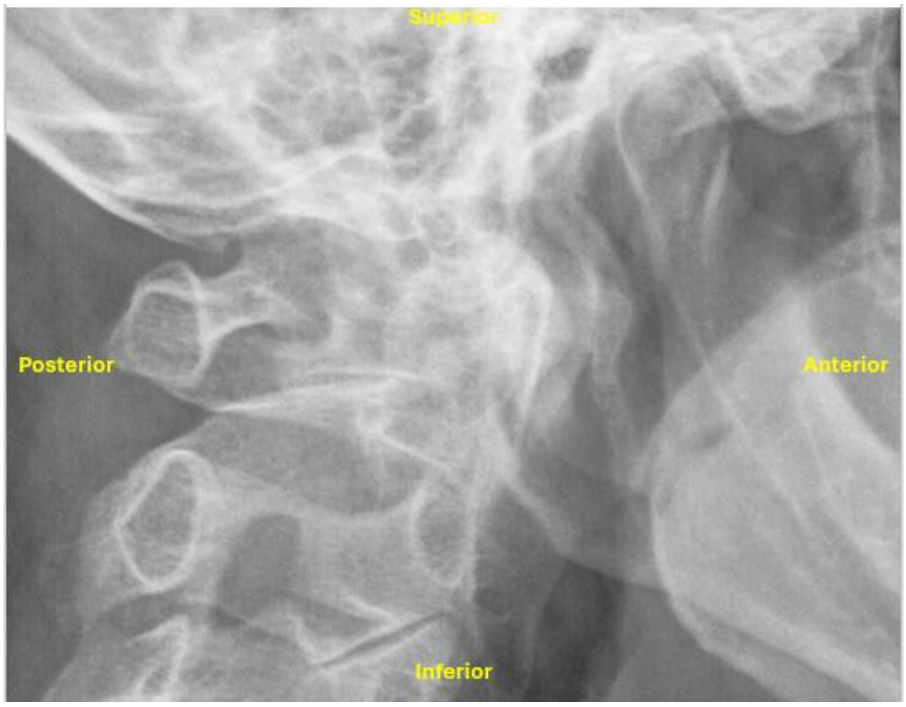
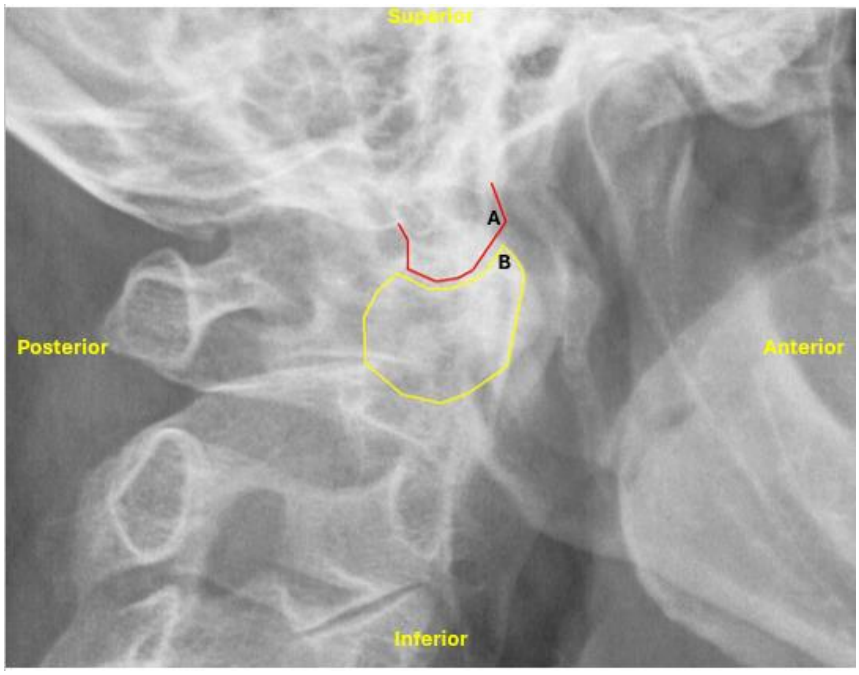
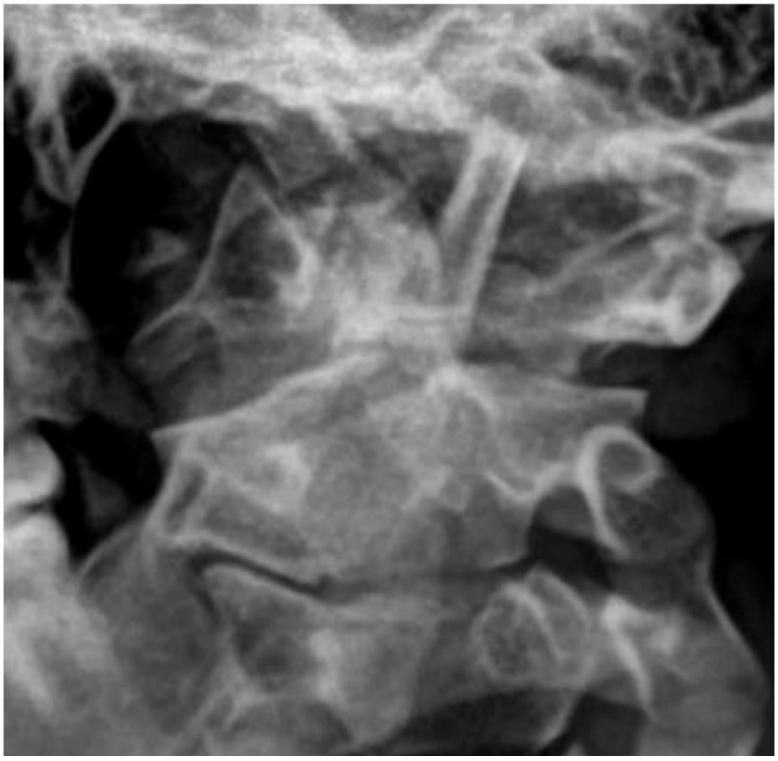


Figure 2d (marked); Patient position: facing bucky, right maximal cervical rotation; **Structures viewed:** left occipital condyle, left Atlas lateral mass; **Points of analysis:** (A) occipital condyle (anterior-superior tip), (B) Atlas lateral mass (anterior-superior tip). **Subluxation listing:** Atlas PIL.



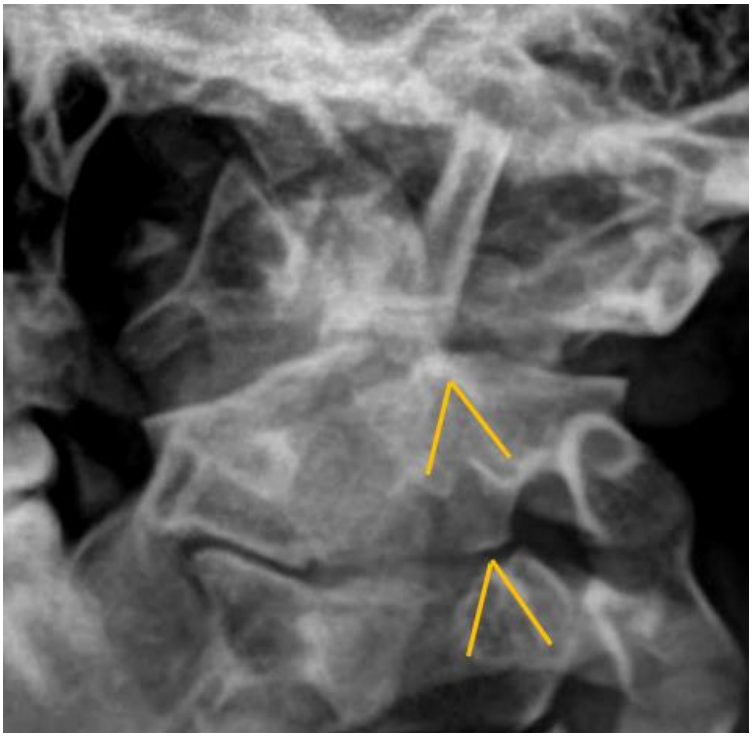
KCSC Peritrope X-ray: Left Maximal Cervical Rotation (Axis PI listings)

Figure 3a (unmarked); Patient position: facing bucky, left maximal cervical rotation; **Structures viewed:** C2 and C3 spinous processes.



KCSC Peritrope X-ray: Right Maximal Cervical Rotation (Atlas PI listings)

Figure 3c (marked); Patient position: facing bucky, left maximal cervical rotation; **Structures viewed:** C2 and C3 spinous processes; **Points of analysis:** C2 and C3 spinous processes; **Subluxation listing:** Axis PLI.



KCSC Peritrope X-ray: Right Maximal Cervical Rotation (Axis PI listings)

Figure 3c (unmarked); Patient position: facing bucky, right maximal cervical rotation; **Structures viewed:** C2 and C3 spinous processes.

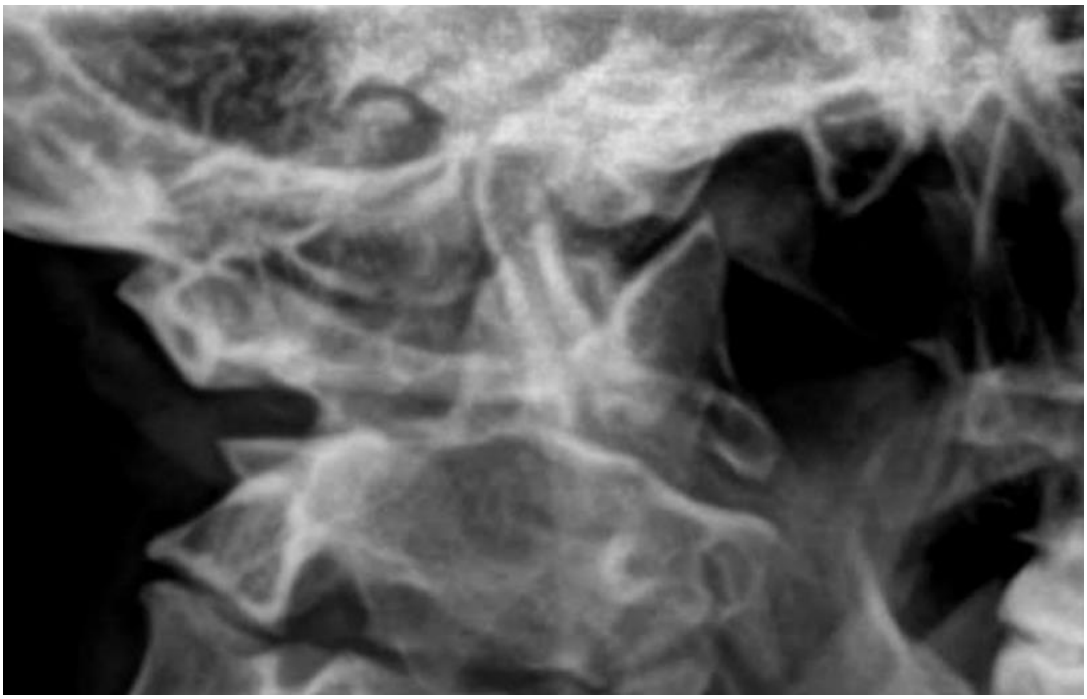


Figure 3d (marked); Patient position: facing bucky, right maximal cervical rotation; **Structures viewed:** C2 and C3 spinous processes.