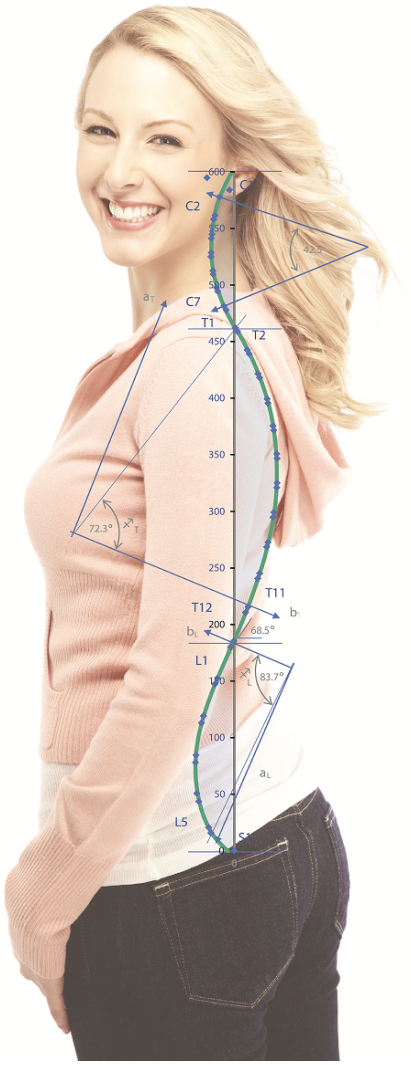
PostureRay®

Exacting X-Ray Analysis

Radiographic Impression Report



Prepared for:	Trent Ashburn
Patient #:	AshburnTrent20211116000
Insurance #:	
Gender:	Male
Date of Birth:	4/29/1978
Address:	
Evaluation Date:	11/16/2021
Date X-Ray Taken:	11/16/2021

Prepared by:
Katz Chiropractic & Rehab Clinic
2727 Pine Street Unit 1
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80302

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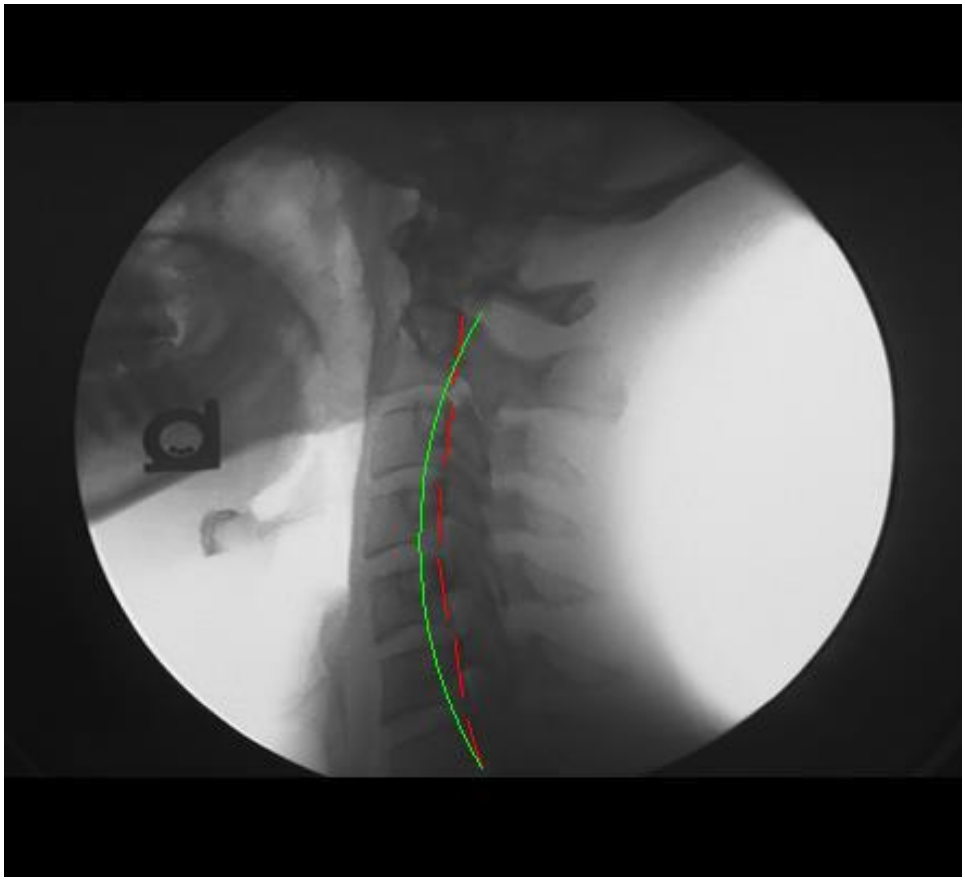
Radiographic Impression Report — Lateral Cervical Projection

Name: Trent Ashburn **X-Ray was obtained: 11/16/2021** **Date of Digitization: 11/16/2021**
Date of Birth: 4/29/1978

Mr. Trent Ashburn's x-rays were analyzed utilizing the PostureRay® computerized X-ray digitizing system with impressions interpreted by Evan Katz D.C. X-Ray digitization for spinal biomechanics has been shown to be valid when compared to standard hand drawn methods. The patient's findings were then compared to established normals at each level and then globally. The X-Ray mensuration method used in analyzing this patient have been studied for reliability and validity and these results are as follows:



Anterior **Posterior**

This green curved line represents the Normal Spinal Position and expected path of the posterior longitudinal ligament.

This red line represents the patient's position and the path of the posterior longitudinal ligament.

Radiographic Impression Report — Lateral Cervical Projection

Spinal Biomechanics Compared to Normal

Segments Analyzed	RRA Normal Values	RRA Patient Values	Difference From Normal	Segmental Translations
C1 to Horiz.	-29.0º	-26.9º	7.2%	
C2-C3	-10.0º	-1.5º	85.0%	-0.9 mm
C3-C4	-8.0º	-2.6º	67.5%	-2.1 mm
C4-C5	-8.0º	-12.5º	56.2%	-1.2 mm
C5-C6	-8.0º	0.3º	103.8%	0.4 mm
C6-C7	-8.0º	-8.7º	8.7%	-1.3 mm

RRA = Relative Rotational Angle of Measurement

Global Analysis	Normal Values	Patient Values	Diff. From Normal
ARA C2-C7 (Segmental Sum.)	-42º	-25.0º	40.5%
ARA C2-C7 (Global)	-42º	-25.1º	40.2%
Translation C2-C7	0 mm	5.1 mm	5.1 mm
C7 Post. Tangent to Vert.	21.5º	16.6º	22.8%
T1 Post. Tangent to Vert.	26.5º	Not Digitized	Not Digitized

ARA = Absolute Rotational Angle of Measurement
Direction of measured displacements are indicated using the right-hand Cartesian coordinate system method in biomechanics. Consequently a "-" negative sign preceding a measured value indicates posterior translation for linear movements; and a "-" preceding angular measurements indicate relative segmental or global extension rotational movement.

Cervical Morphology	Average Values	Patient Values	Diff. From Average
C0-C1 Chamberlain's to APL	n/a	-26.8º	n/a
C2 Pos. body of C2 relative to APL	n/a	74.5º	n/a

APL = Atlas Plane Line
Direction of measured displacements are indicated using the right-hand Cartesian coordinate system method in biomechanics. Consequently a "-" negative sign preceding a measured value indicates posterior translation for linear movements; and a "-" preceding angular measurements indicate relative segmental or global extension rotational movement.

Upper Cervical Measurements	Normal Values	Patient Values	Clinical Significance
Powers Ratio	0.9 to 1	0.8	could indicate posterior dislocations, fractures of the odontoid process or ring of C1, or congenital abnormalities of the foramen magnum
Basilar Impression (Macrae's method)	n/a	WNL	WNL
Atlanto-Dental Interspace	≤ 3 mm	2.8 mm	WNL
Spinal Canal Diameter	> 13 mm	29.8 mm	WNL
Chamberlain's line to horizontal	n/a	2.9º	n/a

WNL = Within Normal Levels

Radiographic Impression Report — Lateral Cervical Projection

Impressions and Assessment

The posterior tangent method of radiographic analysis has been studied extensively for both validity and reliability[1;2-5], and has been shown to be a superior method of analysis for biomechanical assessment over the Cobb method of x-ray analysis for sagittal cervical spine.[3] Using this radiographic analysis technique, the normal cervical lordosis measured from C2-C7 for a normal average population was found to measure -34º with ideal alignment measuring -42º.[1;2] (Note that the negative sign preceding the measurement of degree indicates direction, thus the normal Lordotic/extended position and an abnormal flexion angle/kyphosis is noted by a positive angle). There is a statistically significant association between cervical pain and lordosis < -20º and a "clinically normal" range for cervical lordosis of -31º to -40º.[6] Further, there is no evidence that hypertonicity as seen in muscle spasms in muscle groups responsible for anterior cervical translation and head flexion have any significant impact on cervical lordosis.[7]

As noted in this computerized analysis, Mr. Trent Ashburn's cervical spine measures -25.0º. This is a loss from the expected normal lordosis by 40.5%. Regarding anterior cervical translation (weight bearing) findings of less than 15mm has been established as a normal.[1;2] Mr. Trent Ashburn has a normal anterior cervical translation from C2 relative to C7 of 5.1mm.

References

[1] Harrison DD, Harrison DE, Janik TJ et al. Modeling of the sagittal cervical spine as a method to discriminate hypolordosis: results of elliptical and circular modeling in 72 asymptomatic subjects, 52 acute neck pain subjects, and 70 chronic neck pain subjects. Spine (Phila Pa 1976.) 2004;29:2485-92.
[2] Harrison DD, Troyanovich SJ, Harrison DE et al. A normal sagittal spinal configuration: a desirable clinical outcome. J.Manipulative Physiol Ther. 1996;19:398-405.
[3] Harrison DE, Harrison DD, Cailliet R et al. Cobb method or Harrison posterior tangent method: which to choose for lateral cervical radiographic analysis. Spine (Phila Pa 1976.) 2000;25:2072-8.
[4] Harrison DE, Holland B, Harrison DD et al. Further reliability analysis of the Harrison radiographic line-drawing methods: crossed ICCs for lateral posterior tangents and modified Risser-Ferguson method on AP views. J.Manipulative Physiol Ther. 2002;25:93-8.
[5] Jackson BL, Harrison DD, Robertson GA et al. Chiropractic biophysics lateral cervical film analysis reliability. J.Manipulative.Physiol.Ther. 1993;16:384-91.
[6] McAviney J, Schulz D, Bock R et al. Determining the relationship between cervical lordosis and neck complaints. J.Manipulative Physiol Ther. 2005;28:187-93.
[7] Fedorchuk, CA, McCoy M, Lightstone DF, et al. Impact of Isometric Contraction of Anterior Cervical Muscles on Cervical Lordosis. J Radiol Case Rep. 2016 Sep 30;10(9):13-25. eCollection 2016

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Radiographic Impression Report — Lateral Cervical Flexion/Extension

Name: Trent Ashburn **X-Ray was obtained: 11/16/2021** **Date of Digitization: 11/16/2021**
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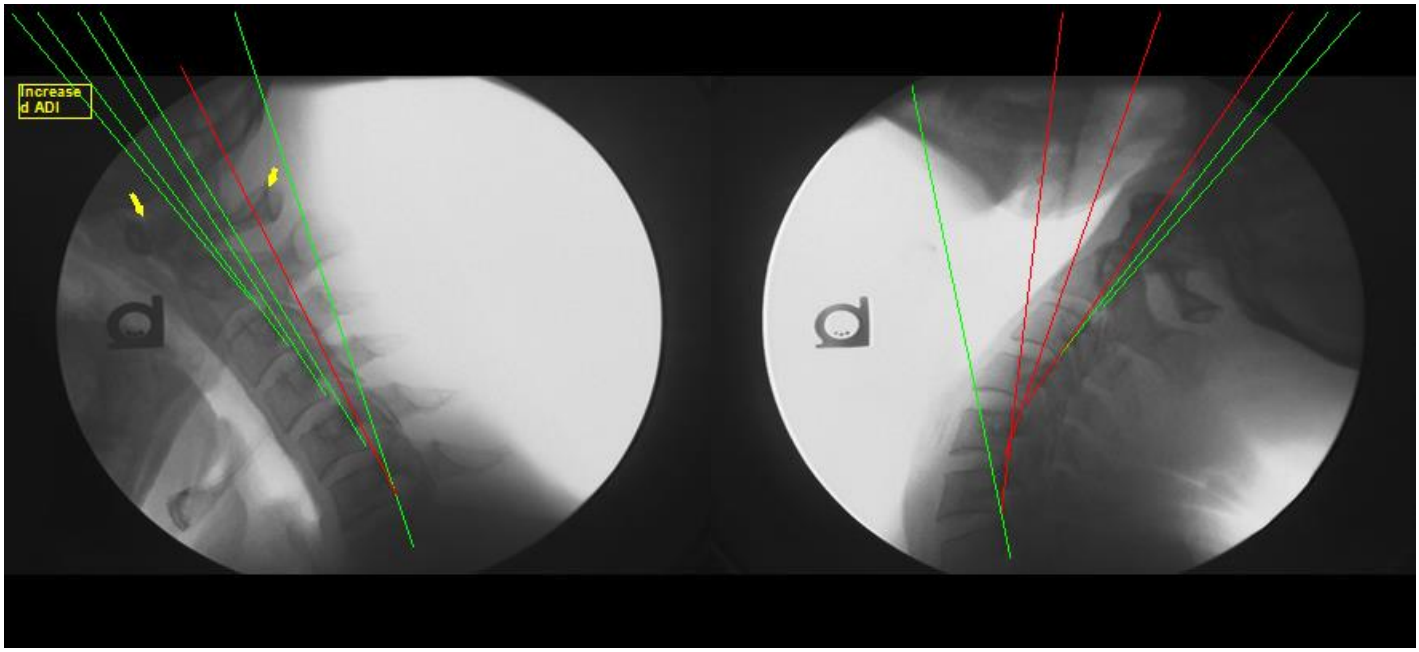
Mr. Trent Ashburn's x-rays were analyzed utilizing the PostureRay® computerized X-ray digitizing system with impressions interpreted by Evan Katz D.C. X-Ray digitization for spinal biomechanics has been shown to be valid when compared to standard hand drawn methods. The patient's findings were then compared to established normals at each level and then globally. The X-Ray mensuration method used in analyzing this patient have been studied for reliability and validity and these results are as follows:

Flexion **Extension**



Anterior **PosteriorAnterior** **Posterior**

This red line represents the posterior tangent lines of mensuration and exceeds normal allowable segmental motion indicating ligament laxity.

This green line represents the posterior tangent lines of mensuration and appears to be stable with no significant ligamentous laxity.

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Radiographic Impression Report — Lateral Cervical Flexion/Extension

Flexion/Extension Values

Segment	Flexion RRA*	Extension RRA*	Angular Excursion**	Flexion Translation***	Extension Translation***	Translational Excursion
C1 to Horiz.	11.8º	-68.4º				
C2-C3	2.8º	-3.0º	5.8º	0.1 mm	-3.4 mm	3.5 mm
C3-C4	4.0º	-3.8º	7.8º	0.3 mm	-2.2 mm	2.5 mm
C4-C5	1.5º	**-14.9º**	16.4º	2.0 mm	-2.5 mm	4.5 mm
C5-C6	4.9º	**-12.4º**	17.3º	1.3 mm	0.2 mm	1.1 mm
C6-C7	8.1º	**-18.8º**	**26.9º**	-1.9 mm	-0.8 mm	1.1 mm
C7-T1	Not Digitized	Not Digitized	n/a	Not Digitized	Not Digitized	n/a

RRA = Relative Rotational Angle of Measurement
* Values in Red Exceed Established Normal of 11º
** Values in Red Exceed Established Normal of 23º
*** Values in Red Exceed Established Normal of 3.5mm

Global Analysis	Flexion	Extension	Global Excursion
ARA C2-C7 (Segmental Summation)	21.3º	-52.9º	74.2º
ARA C2-C7 (Global)	21.3º	-52.9º	74.1º
Translation C2-C7	77.2 mm	-49.5 mm	126.7 mm
C7 Post. Tangent to Vert.	18.4º	11.8º	6.6º
T1 Post. Tangent to Vert.	Not Digitized	Not Digitized	n/a

ARA = Absolute Rotational Angle of Measurement
Direction of measured displacements are indicated using the right-hand Cartesian coordinate system method in biomechanics. Consequently a "-" negative sign preceding a measured value indicates posterior translation for linear movements; and a "-" preceding angular measurements indicate relative segmental or global extension rotational movement.

Cervical Morphology	Flexion	Extension	Global Excursion
C2 Pos. body of C2 relative to APL	62.6º	63.5º	-0.9º

APL = Atlas Plane Line
Direction of measured displacements are indicated using the right-hand Cartesian coordinate system method in biomechanics. Consequently a "-" negative sign preceding a measured value indicates posterior translation for linear movements; and a "-" preceding angular measurements indicate relative segmental or global extension rotational movement.

Upper Cervical Measurements - Flexion	Normal Values	Patient Values	Clinical Significance
Powers Ratio	0.9 to 1	Not Digitized	n/a
Basilar Impression (Macrae's method)	n/a	Not Digitized	n/a
Atlanto-Dental Interspace	≤ 3 mm	4.0 mm	Transverse Ligament Laxity
Spinal Canal Diameter	> 13 mm	30.9 mm	WNL
Chamberlain's line to horizontal	n/a	Not Digitized	n/a

WNL = Within Normal Levels

Radiographic Impression Report — Lateral Cervical Flexion/Extension

Upper Cervical Measurements - Extension	Normal Values	Patient Values	Clinical Significance
Powers Ratio	0.9 to 1	Not Digitized	n/a
Basilar Impression (Macrae's method)	n/a	Not Digitized	n/a
Atlanto-Dental Interspace	≤ 3 mm	1.8 mm	WNL
Spinal Canal Diameter	> 13 mm	28.1 mm	WNL
Chamberlain's line to horizontal	n/a	Not Digitized	n/a

WNL = Within Normal Levels

Upper Cervical Measurements - Flexion + Extension	Normal Values	Patient Values	Clinical Significance
C0-C1 Instability	< 25º	Not Digitized	n/a
C1-C2 Instability	< 20º	14.5º	WNL

WNL = Within Normal Levels

Impressions and Assessment

The posterior tangent method of radiographic analysis has been studied extensively for both validity and reliability[4-8], and has been shown to be a superior method of analysis for biomechanical assessment over the Cobb method of x-ray analysis for sagittal cervical spine.[6] Normal values for intersegmental motion should not exceed more than 10-11º of angular motion.[9] Using the posterior tangent method of radiographic analysis, motion that exceeds 10º has been shown to predict and discriminate minor ligamentous injuries from those patients with true whiplash type ligamentous injuries.[3] Corroborating these findings using another method of analysis (inferior endplate assessment), an alteration of motion segment integrity (AOMSI) has been defined as motion at the level in question that is more than 11º greater than at either adjacent level.[1] Regarding segmental translational movements, authors have noted that subluxation should be noted with a range of 1.0-3.0mm[2] of intersegmental movement with absolute clinical cutoff threshold value of 3.5mm.[1;9] Of additional importance, improvement in neutral lateral cervical lordosis has been shown to be associated with significant improvement in the translational and rotational motions of the lower cervical spine. Flexion/extension kinematics are partially dependent on the posture and sagittal curve orientation.[10]

There is anterior widening of the intervertebral disc space at C4-C5, C5-C6, C6-C7 levels evidenced by excessive segmental extension, which indicates probable damage to the anterior longitudinal ligament and/or intervertebral disc at said level.

- Segmental flexion instability is noted at the following segments: none
- Segmental extension instability is noted at the following segments: C4-C5 of -14.9º, C5-C6 of -12.4º, C6-C7 of -18.8º.
- Segmental angular excursion instability is noted at the following segments: C6-C7 of 26.9º.
- Segmental subluxation for flexion is noted at the following segments: C4-C5 with 2.0 mm, C5-C6 with 1.3 mm, C6-C7 with -1.9 mm.

Radiographic Impression Report — Lateral Cervical Flexion/Extension

- Segmental subluxation for extension is noted at the following segments: C2-C3 with -3.4 mm, C3-C4 with -2.2 mm, C4-C5 with -2.5 mm.
- Segmental translational instability for flexion is noted at the following segments: none
- Segmental translational instability for extension is noted at the following segments: none

According to the above biomechanical assessment, there are findings of alteration of motion segment integrity (AOMSI) at the following levels: C4-C5, C5-C6 and C6-C7. Consequently, this patient may be rateable for a permanent injury upon reaching maximal medical improvement.

References

[1] Guides to the Evaluation of Permanent Impairment, Fifth Edition.American Medical Association, 2000.
[2] Green JD, Harle TS, Harris JH, Jr. Anterior subluxation of the cervical spine: hyperflexion sprain. AJNR Am.J.Neuroradiol. 1981;2:243-50.
[3] Griffiths HJ, Olson PN, Everson LI et al. Hyperextension strain or "whiplash" injuries to the cervical spine. Skeletal Radiol. 1995;24:263-6.
[4] Harrison DD, Harrison DE, Janik TJ et al. Modeling of the sagittal cervical spine as a method to discriminate hypolordosis: results of elliptical and circular modeling in 72 asymptomatic subjects, 52 acute neck pain subjects, and 70 chronic neck pain subjects. Spine (Phila Pa 1976.) 2004;29:2485-92.
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[8] Jackson BL, Harrison DD, Robertson GA et al. Chiropractic biophysics lateral cervical film analysis reliability. J.Manipulative.Physiol.Ther. 1993;16:384-91.
[9] White AA, III, Johnson RM, Panjabi MM et al. Biomechanical analysis of clinical stability in the cervical spine. Clin.Orthop. 1975;85-96.
[10] Moustafa IM, et al. Does rehabilitation of cervical lordosis influence sagittal cervical spine flexion extension kinematics in cervical spondylotic radiculopathy subjects? J Back Musculoskelet Rehabil. 2016 Mar 27. doi: 10.3233/BMR-150464.

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Radiographic Impression Report — AP Open Mouth

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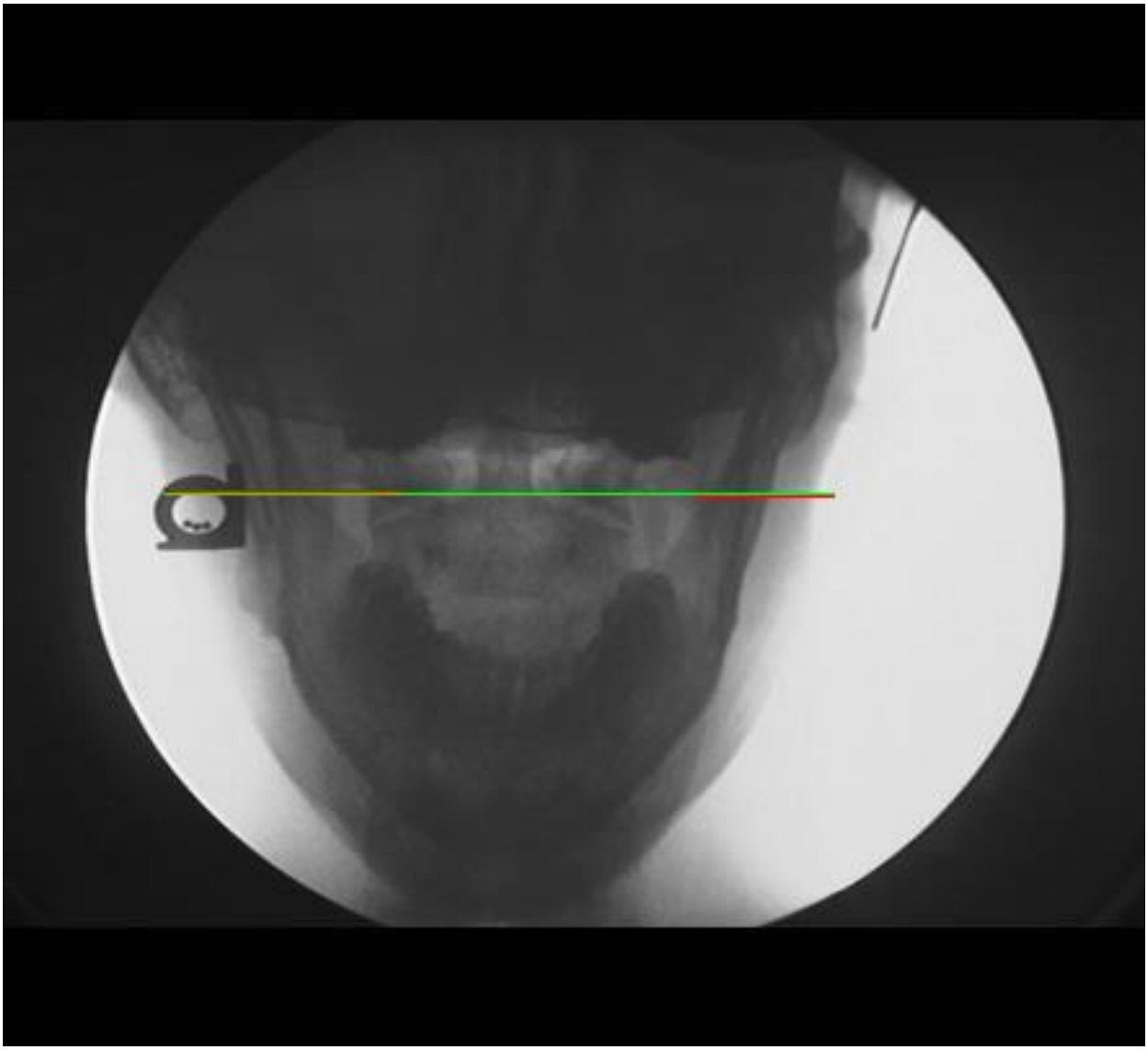

X-ray Left **X-ray Right**

The horizontal green line represents the normal atlas position. The vertical green line is a plumb line, also indicating normal vertical spinal alignment.

The horizontal red line represents the patient's Atlas vertebrae position. Ideally this should superimpose the green normal horizontal line. The red vertically oriented line should superimpose the true green vertical plumb line in spines with normal alignment.

Radiographic Impression Report — AP Open Mouth

Neutral Values

Global Analysis	Normal Values	Patient Values	Difference From Normal	Clinical Significance
C0-C1 Lat. Flex. Angle	0.0º	1.9º	1.9º	WNL
C1-C2 Lat. Flex. Angle	0.0º	0.6º	0.6º	WNL
C2-C3 Lat. Flex. Angle	0.0º	Not Digitized	n/a	
Left C1-C2 "overhang" margin	0.0 mm	left 0.7 mm	0.7 mm	WNL
Right C1-C2 "overhang" margin	0.0 mm	left 1.0 mm	1.0 mm	WNL
C2 Axial Spinous Rotation	0.0º	Not Digitized	n/a	

WNL = Within Normal Levels

Direction of measured displacements are indicated using the right-hand Cartesian coordinate system method in biomechanics. Consequently a "-" negative sign preceding a measured value indicates left translation for linear movements; and a "-" preceding angular measurements indicate relative segmental or global rotational movement to the left.

Impressions and Assessment

As noted above in the table for the neutral position, Mr. Trent Ashburn has a 0.7 mm left shift of C1 relative to the lateral body margin of C2 on the left side. On the patient's right side, there is a 1.0 mm left shift of C1 relative to the lateral body margin of C2.

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Radiographic Impression Report — AP Open Mouth Bending

Name: Trent Ashburn **X-Ray was obtained: 11/16/2021** **Date of Digitization: 11/16/2021**
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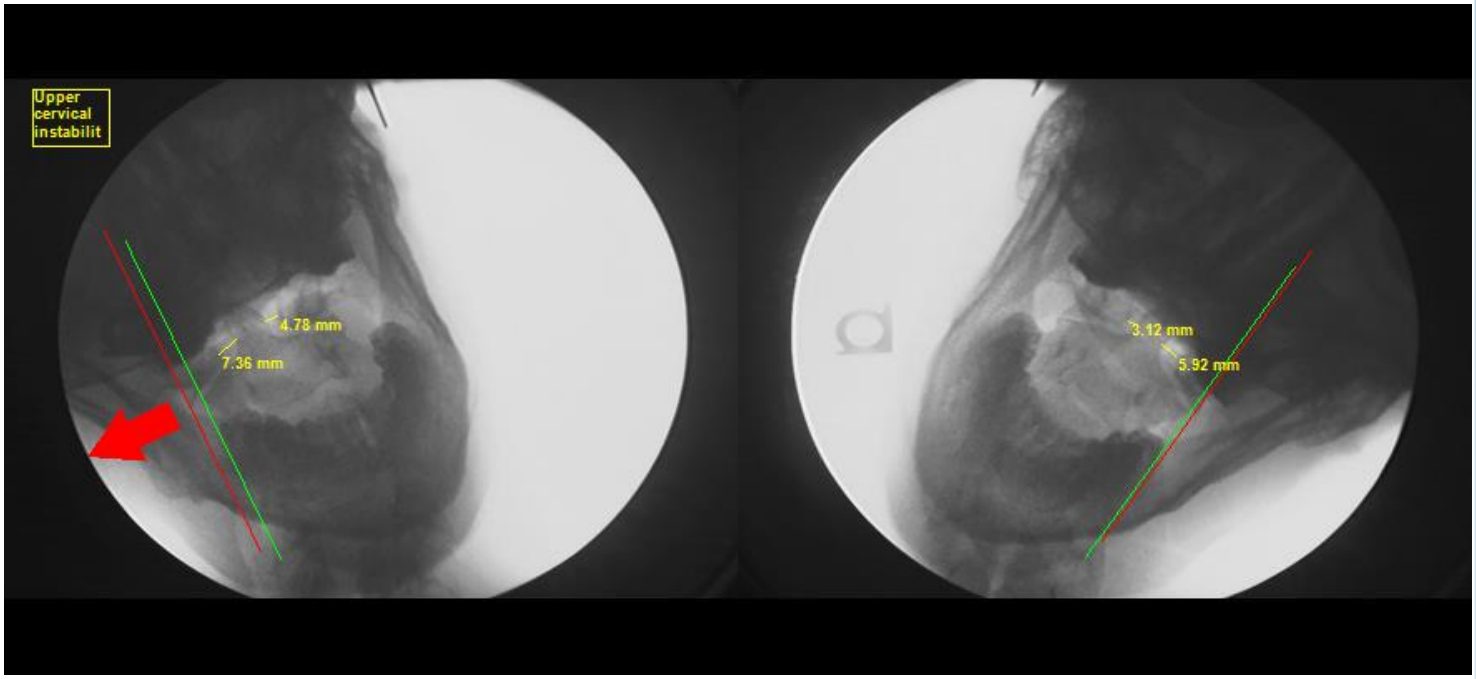
Left Lateral Flexion **Right Lateral Flexion**



X-ray Left **X-ray RightX-ray Left** **X-ray Right**

The red line represents the position of the atlas lateral mass in the side bending position.

The green line represents the position of the Axis superior articular process. Shifting of the red line from green greater than 3.0mm laterally indicates probable damage to the Alar and Accessory ligaments.

Left Cervical Bending Values

Global Analysis	Normal Levels	Patient Values	Clinical Significance
C0-C1 Lat. Flex. Angle	< 5.0º	1.9º	WNL
C1-C2 Lat. Flex. Angle	< 5.0º	3.2º	WNL
C2-C3 Lat. Flex. Angle	< 20.0º	Not Digitized	
C1-C2 Overhang	< 3.0 mm	**left 5.2 mm**	Possible Instability
C2 Axial Spinous Rotation	< 10.0º *	**right 28.8º**	Possible Instability

WNL = Within Normal Levels

* Some research indicates some subjects can have up to 14º of C2 spinous rotation with a large lateral bending of C2 on C3 but most research indicates C2 Spinous rotation of less than 10º as an upper limit.

Direction of measured displacements are indicated using the right-hand Cartesian coordinate system method in biomechanics. Consequently a "-" negative sign preceding a measured value indicates left translation for linear movements; and a "-" preceding angular measurements indicate relative segmental or global rotational movement to the left.

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Radiographic Impression Report — AP Open Mouth Bending

Right Cervical Bending Values

Global Analysis	Normal Levels	Patient Values	Clinical Significance
C0-C1 Lat. Flex. Angle	< 5.0º	1.8º	WNL
C1-C2 Lat. Flex. Angle	< 5.0º	0.4º	WNL
C2-C3 Lat. Flex. Angle	< 20.0º	Not Digitized	
C1-C2 Overhang	< 3.0 mm	right -1.5 mm	WNL
C2 Axial Spinous Rotation	< 10.0º *	**left 19.0º**	Possible Instability

WNL = Within Normal Levels

* Some research indicates some subjects can have up to 14º of C2 spinous rotation with a large lateral bending of C2 on C3 but most research indicates C2 Spinous rotation of less than 10º as an upper limit.

Direction of measured displacements are indicated using the right-hand Cartesian coordinate system method in biomechanics. Consequently a "-" negative sign preceding a measured value indicates left translation for linear movements; and a "-" preceding angular measurements indicate relative segmental or global rotational movement to the left.

Impressions and Assessment

For the left position, Mr. Trent Ashburn has a C1-C2 Left Translation of 5.2 mm and a C1-C2 Right Translation of 2.9 mm. Relative to the neutral position, a right C2 Axial Rotation of 28.8º was observed.When the patient bends to the left there is movement of 5.2 mm. This displacement overhang of C1 on C2 indicates possible unilateral damage of the Alar and/or Accessory Ligaments.

For the right position, Mr. Trent Ashburn has a C1-C2 Left Translation of -1.5 mm and a C1-C2 Right Translation of -1.5 mm. Relative to the neutral position, a left C2 Axial Rotation of 19.0º was observed.

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Radiographic Impression Report

Other View - oblique flex facet gap

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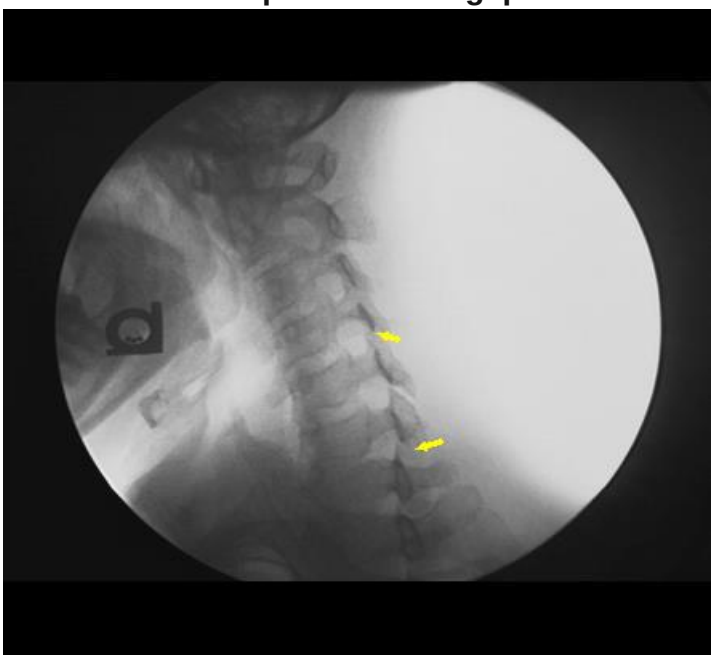
oblique flex facet gap



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Radiographic Impression Report

Other View - oblique flex facet gap

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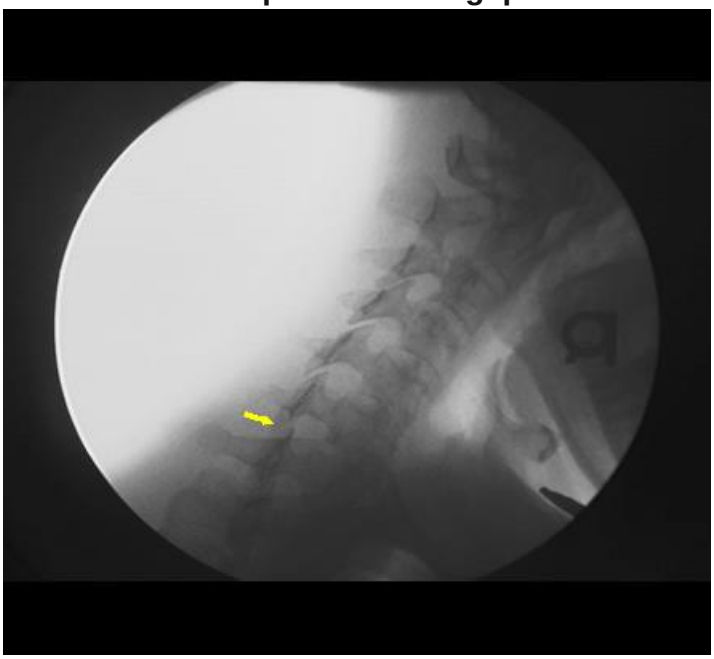
oblique flex facet gap



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Radiographic Impression Report

Other View - lateral flex

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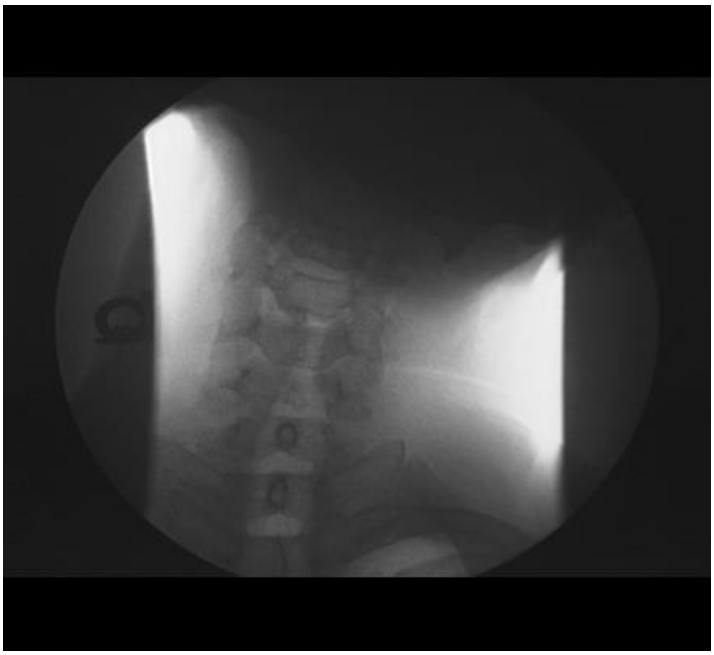
Date of Birth: 4/29/1978

lateral flex



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Radiographic Impression Report

Other View - lateral flex

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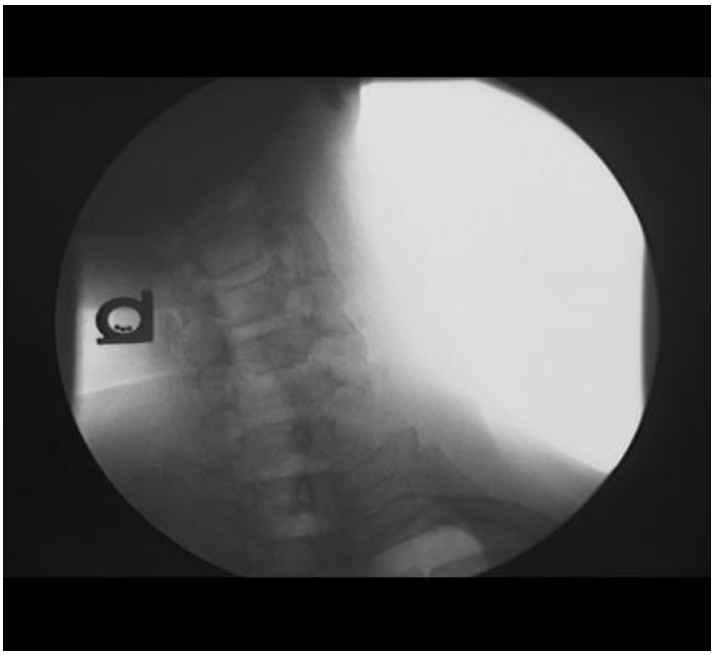
lateral flex



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Radiographic Impression Report

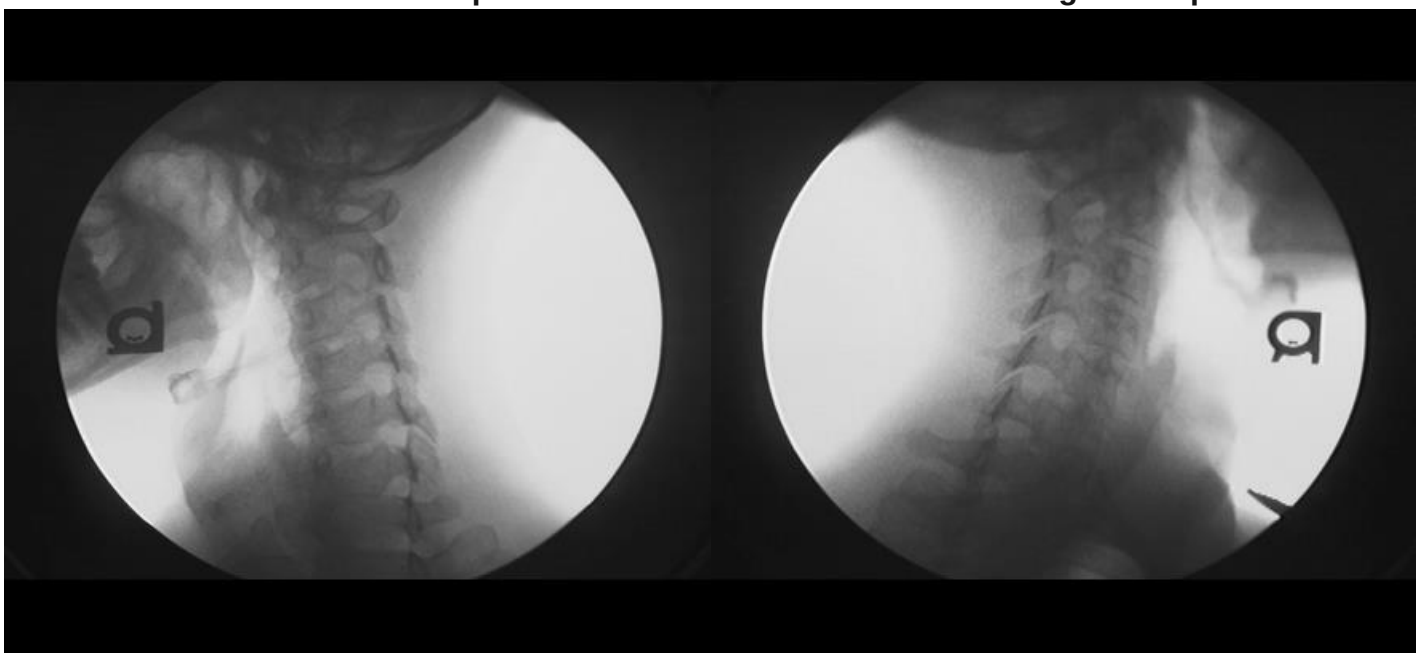
Other View - Cervical Oblique

Name: Trent Ashburn **X-Ray was obtained: 11/16/2021** **Date of Digitization: 11/16/2021**

Date of Birth: 4/29/1978

Cervical Left Oblique

Cervical Right Oblique



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