

Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) Findings in Operatively and Non-Operatively Managed Unilateral Cervical Facet Fractures

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## **Learning Objectives**

To discuss injury characteristics associated with unilateral cervical facet fractures and discuss CT and MRI findings or injury characteristics associated with surgically managed patients

#### Introduction

Studies show cervical facet fracture instability is related to certain Computed tomography (CT) and Magnetic Resonance Imaging (MRI) findings. This retrospective descriptive study of patients with unilateral cervical facet fractures (UCFF) further examines CT and MRI findings associated with surgical and non-surgical management of such injury.

## Methods

Demographics (age, gender, race), clinical (comorbidities, mechanism of injury, Glasgow Coma Score), and CT/MRI imaging data of 225 patients with UCFF identified by CT and managed at University of Louisville Hospital, a level-1-trauma center, from 2011-2014 were retrospectively collected. 135 patients had additional imaging with Magnetic Resonance Imaging (MRI) cervical spine without contrast. Patients were further classified into two groups of those surgically and nonoperatively managed to compare imaging findings listed in Tables 1 and 2.



# Methods (Continued)

Bilateral facet fractures and other cervical injuries, such as dislocations or additional fractures, were excluded. Unadjusted analyses were first performed to evaluate the effect of demographics, clinical characteristics, CT findings and MRI findings on surgery. Mann Whitney U tests were used for continuous variables and Chi-square tests were used for categorical variables. All tests were two-sided and effects were statistically significant if pvalue<0.05. The data preparation and data analysis were performed using SAS 9.4.

#### Results

The 225 patients with UCFF identified were 71% male, 82% white, and average age 42 years. Primary mechanism of injury was motor vehicle accident (79%). Most patients were GCS=13 (90%). Lateral Mass Fractures (31%) infrequently received surgery (31%, p=0.232). Per CT, most common injury level was C6-C7 (48%). 42% fractures height were >1cm (Table 1.1). Most common level to have surgery was C4-C5 (45%) (Table 1.1).

Demographics	nographics Surgically g-value Treated		Computed Tomography Image Findings (cont.)	Surgically Treated	g-value
Age			Involved articular facets [yes vs. no]		
Mean (STD)	41.6 vs. 43.2		Superior	23.2% vs. 41.0%	0.004*
Median (Q1-Q3)	41.0 vs. 42.5	0.638	Inferior	36.6% vs. 30.1%	0.315
Gender: female vs. male	22.7% vs. 36.5%	0.045*	Both Superior and Inferior	51.4% vs. 28.9%	0.009*
Race [yes vs. no]			Fracture Orientation [present vs. absent]		
Caucasian	31.9% vs. 35.0%	0.703	Sagittal	33.1% vs. 31.4%	0.792
African American	35.7% vs. 31.9%	0.693	Axial	42.3% vs. 31.2%	0.253
Asian	0.00% vs. 32.9%	0.227	Coronal	30.2% vs. 33.6%	0.635
Hispanic	28.6% vs. 32.6%	0.824	Other fracture characteristics [yes vs. no]		
Other	100% vs. 31.8%	0.040*	Fracture fragments in foramen	70.3% vs. 25.0%	<0.001*
Clinical Characteristics			Subluxation	64.6% vs. 19.4%	<0.001*
Comorbidities [present vs. absent]			Facet fracture absolute height >1cm	41.5% vs. 25.9%	0.014*
Osteoporosis	22.2% vs. 32.9%	0.504	Kyphosis/Deformity Ferguson (20-40deg)	72.7% vs. 30.4%	0.003*
Diabetes Mellitus	19.1% vs. 33.8%	0.169	Rotation Angle (>10deg)	95.0% vs. 26.4%	<0.001*
Hypertension	38.2% vs. 30.6%	0.296	Associate fractures [present vs. absent]		
Toharco abuse	35 5% vs 29 7%	0.349	Senarate fracture	33 9% vs 27 1%	0.371
Alcohol abuse	36 4% 11 30 8%	0.419	Lateral mass	41 9% vs 31 1%	0.232
Obesity	39 2% + 30 5%	0.24	Padicle	35.9% vs. 31.4%	0.545
Glassow Coma Score (vera	nol	0.4.4	Initiateral pedicle	32 7% vs 32 4%	0.972
Sauras (1.8)	19 28	0.2	Controlatoral andiala	62 5W up 31 3W	0.065
Moderate (0.12)	16 7% ur 23 2%	0.22	Eacot level pedicle	20 1% 1 20 7%	0.005
Mines (13, 15)	24.2% or 17.4%	0.104	faire and a second	55.2N V2. 30.7N	0.108
Million (13-13)	34.276 V3. 17.475	0.104	Spinous process	54.0% vs. 31.3%	0.105
Motor Vehicle	s. noj		Pacet level spinous process	33.0% Vs. 31.3%	0.151
Accident	30.3% vs. 40.4%	0.189	Facet level anterior compress	53.3% vs. 30.9%	0.074
Fall	33.3% vs. 32.3%	0.916	Vertebral body burst	62.5% vs. 31.3%	0.065
Blunt Trauma	40.9% vs. 31.5%	0.372	Facet level vertebral body burst	57.1% vs. 29.9%	0.011*
SLIC [yes vs. no]			Anterior vertebral body compression	52.6% vs. 30.6%	0.049*
<4	13.8% vs. 86.2%	<0.001*	Facet level anterior vertebral body compression	34.4% vs. 31.0%	0.594
=4	68.2% vs. 28.6%	<0.001*	Lamina	31.0% vs. 33.3%	0.719
>4	97.2% vs. 20.1%	<0.001*	Ipsilateral lamina	50.0% vs. 31.8%	0.28
Computed Tomography Im	age Findings		Contralateral lamina	37.7% vs. 29.3%	0.194
injury level [yes vs. no]		-	Facet level laminas	39.1% vs. 28.3%	0.091
C1-C2	0.0% vs. 33.0%	0.162	Transverse process	31.0% vs. 33.3%	0.719
C2-C3	27.3% vs. 32.7%	0.707	Ipsilateral transverse process	38.5% vs. 32.1%	0.633
C3-C4	36.0% vs. 32.0%	0.687	Facet level transverse process	40.8% vs. 28.2%	0.056
C4-C5	45.5% vs. 30.2%	0.084	C2 vertebral body fracture	0.0% vs. 33.5%	0.063
C5-C6	27.7% vs. 33.7%	0.431	Thoracic fracture	31.7% vs. 32.7%	0.881
C6-C7	32.4% vs. 32.5%	0.991	Lumbar fracture	20.0% vs. 33.7%	0.213
C7-T1	33.3% vs. 32.3%	0.906	Multiple ipsilateral cervical facet fractures	46.3% vs. 29.4%	0.037*
ide of presentation (yes v	. no]				
Left	34.2% vs. 30.5%	0.555			
Plake	20 59 24 39	0.555			

## Results (Continued)

Per MRI (Tables 2.1 & 2.2), patients with ligamentum flavum (38%), posterior longitudinal ligament (57%), or anterior longitudinal ligament (50%) involvement more likely underwent surgery (66%, 67%, 70%, respectively, p<0.05) (Table 2.1,2.2). Disc disruption (30%) and nucleus pulposus herniation (23%) associated more with surgical than conservative management (77% and 74%, respectively, p<0.05) (Table 2.1,2.2). SLIC<4 (61%) less commonly received surgical intervention (20%; p<0.05). SLIC=5 (24%) associated with a higher percentage of surgical intervention (61%, p< 0.05).

## Discussion

This study, one of the largest reported on UCFF studies, reports the level most commonly injured (C6-C7) and levels most associated with surgery (C4-C5). Consistent with previous studies subluxation, facet fracture absolute height > 1cm, rotation angle >10°, kyphosis deformity, injury to ISL, LF, PLL, ALL, disrupted discs, nucleus pulposus herniation, circum or anterior annulus fibrosus tears, are associated with surgical intervention. In contrast with the literature, lateral mass facet fractures and joint capsule injury did not show higher association with surgical management. The rate of floating fractures involving pedicle, facet, and lamina was quantified where the majority was managed conservatively.

Demographics	All N=135	Surgically Treated	Magnetic Resonance Imaging Findings	All N=135	Surgical
Age			Involved ligaments, n (%)		
Mean (STD)	42.2 (16.9)	52.3 (16.4)	Posterior musculature/Nuchal ligament	128 (94.8)	62 (48.4
Median (Q1-Q3)	40 (28-53)	42 (28-52)	Interspinous ligaments (ISL)	111 (82.2)	57 (51.4
Gender: female, n (%)	38 (28.2)	14 (36.8)	Supraspinous ligaments (SSL)	35 (26.1)	12 (34.3
Race, n (%)			Ligamentum flavum (LF)	38 (28.4)	25 (65.8
Caucasian	112 (82.9)	52 (46.4)	Facet Capsule Right (FCR)	38 (28.2)	23 (60.5
African American	14 (10.4)	7 (50.0)	Facet Capsule Left (FCL)	43 (31.9)	24 (55.8
Asian	2 (1.5)	0 (0.0)	Posterior longitudinal ligament (PLL)	57 (42.2)	38 (66.7
Hispanic	5 (3.7)	2 (40.0)	Anterior longitudinal ligament (ALL)	50 (37.0)	35 (70.0
Other	2 (1.5)	2 (100.0)	Disc Integrity n (%)		
Clinical Characteristics			Intact	46 (34.1)	11 (23.5
Comorbidities, n (%)			Indeterminant	49 (36.3)	21 (42.5
Osteoporosis	5 (3.7)	2 (40.0)	Disrupted	40 (29.6)	31 (77.5
Diabetes Mellitus	13 (9.6)	4 (30.8)	Herniated Nucleus pulposus (HNP)	31 (22.9)	23 (74.2
Hypertension	33 (24.4)	18 (54.6)	Anulus fibrous Circum	24 (17.8)	16 (66.7
Tobacco abuse	67 (49.6)	31 (46.3)	Anulus fibrous anterior	15 (11.1)	12 (80.0
Alcohol abuse	41 (30.4)	19 (46.3)	Annulus fibrous posterior	43 (31.9)	21 (48.8
Obesity	37 (27.4)	17 (45.9)	Prevertebral Edema, n (%)	52 (38.5)	33 (63.5
Glasgow Coma Score, n (%)					
Severe (1-8)	6 (4.4)	2 (33.3)			
Moderate (9-12)	8 (5.9)	2 (25.0)			
Minor (13-15)	121 (89.6)	59 (48.8)			
Mechanism of injury, n (%)					
Motor Vehicle Accident	103 (76.3)	46 (44.7)			
Fall	19 (14.1)	9 (47.4)			
Blunt Trauma	15 (11.1)	7 (46.7)			
SLIC, n (%)					
<4	83 (61.5)	17 (20.5)			
=4	19 (14.1)	13 (69.4)			
>4	33 (24.4)	33 (100.0)			

# Discussion

Other imaging findings more associated with surgical intervention were fracture fragments in neuroforamen, superior facet fractures, presence of both superior and inferior facet fractures, same facet level vertebral body burst fractures, and anterior vertebral body compression factures, all found on CT, as well as the presence of prevertebral edema found on MRI. Further prospective studies are needed to consider these imaging findings as indications for surgical intervention or predictors of poor outcome with nonoperative management.

# Conclusion

Conservative versus operative management of UCFF is controversial. This injury frequently leads to neurological instability and late mechanical instability. Here we present patient characteristics and imaging findings to help support when early operative intervention and guide conservative treatment. Any deformity/kyphosis, translation, posterior ligamentous complex injury, underlying brittle or osteoporotic bone should prompt surgical consideration.

Demographics	Surgically Treated	g-value	Magnetic Resonance Imaging Findings	Surgically Treated	p-va
Age			Involved ligaments [yes vs. no]		
Mean (STD)	42.3 vs. 42.1		Posterior musculature/Nuchai ligament	48.4% vs. 14.3% 51.45% vs.	0.0
Median (Q1 –Q3)	42.0 vs. 38.5	0.827	Interspinous ligaments (ISL)	25.0%	0.01
Gender: female vs. male	36.8% vs. 50.5%	0.152	Supraspinous ligaments (SSL)	34.3% vs. 51.5%	0.0
Race (yes vs. no)			Ligamentum flavum (LF)	65.8% vs. 39.6%	0.00
Caucasian	46.4% vs. 47.8%	0.903	Facet Capsule Right (FCR)	60.5% vs. 41.2%	0.04
African American	50.0% vs. 46.3%	0.792	Facet Capsule Left (FCL)	55.8% vs. 42.4%	0.1
Asian	0.0% vs. 47.4%	0.183	Posterior longitudinal ligament (PLL)	66.7% vs. 32.1%	<0.0
Hispanic	40.0% vs. 46.9%	0.761	Anterior longitudinal ligament (ALL)	70.0% vs. 32.9%	<0.0
Other	100.0% vs. 45.9%	0.128	Disc Integrity [yes vs. no]		
<b>Clinical Characteristics</b>			Intact	23.9% vs. 58.4%	0.00
Comorbidities (yes vs. no)			Indeterminant	42.9% vs. 48.8%	0.5
Osteoporosis	40.0% vs. 46.9%	0.761	Disrupted	77.5% vs. 33.7%	<0.0
Diabetes Mellitus	30.8% vs. 48.4%	0.227	Herniated Nucleus pulposus (HNP)	74.2% vs. 38.5%	0.00
Hypertension	54.6% vs. 44.1%	0.297	Anulus fibrous Circum	66.7% vs. 42.4%	0.03
Tobacco abuse	46.3% vs. 47.1%	0.927	Anulus fibrous anterior	80.0% vs. 42.5%	0.00
Alcohol abuse	46.3% vs. 46.8%	0.96	Annulus fibrous posterior	48.8% vs. 45.7%	0.7
Obesity	45.9% vs. 46.9%	0.918	Prevertebral Edema [yes vs. no]	63.5% vs. 36.1%	0.00
Glasgow Coma Score (yes vs. no)					
Severe (1-8)	33.3% vs. 47.3%	0.503			
Moderate (9-12)	25.0% vs. 48.0%	0.2053			
Minor (13-15)	48.8% vs. 28.6%	0.1517			
Mechanism of injury [yes vs. no]					
Motor Vehicle Accident	44.7% vs. 53.1%	0.402			
Fall	47.4% vs. 46.6%	0.947			
Blunt Trauma	46.7% vs. 46.7%	1			
SLIC, n (%)					
<4	20.5% vs. 88.5%	<0.001*			
=4	68.4% vs. 43.1%	0.040*			
>4	60.6% vs. 29.4%	<0.001*			

#### References

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