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SNI: Spine

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Original Article

Management of nonoperative cervical spine fractures: An institutional analysis of follow-up duration and image acquisition

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ABSTRACT

Background: How long do nonoperative cervical fractures have to be followed and with how many imaging studies?

Methods: We reviewed 69 adult patients with 122 (31 occiptocervical and 91 sub-axial) cervical fractures; at least one of the cervical fractures was managed nonoperatively. Outcomes were assessed along with the optimal followup duration and frequency of various diagnostic studies.

Results: An average of four follow-up visits occurred on average 28-, 66-, 94-, and 158-day post hospital discharge. The average time between discharge and orthotic clearance was 70 days (±32.4 days). Radiographic studies were obtained at follow-up visits, respectively, in, 82.6%, 83.6%, 94.7%, and 100% of patients.

Conclusion: The trend for managing nonoperative cervical fractures was an unduly prolonged follow-up duration that included obtaining too many imaging studies.

Keywords: Cervical fracture, Cervical spine, Conservative management, Non-operative, Orthotic

INTRODUCTION

Recent studies have reported that 0.6% of the cumulative risk of cancer to 75 years of age can be attributable to diagnostic X-rays and estimate that 0.4% of cancers in the United States are caused by CT scans.^[2,3] Here, in an interest of limiting the number of postoperative X-rays, we analyzed how frequently patients with nonoperative cervical spine fractures underwent postoperative X-ray studies, along with their overall follow-up duration and time to orthosis removal.

MATERIALS AND METHODS

Clinical data

There were 69 patients included in this study (122 fractures) who averaged 58 years of age. The most common mechanism of injury was motor vehicle accidents (n = 27, 39%), followed by

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falls <1 m (n = 21, 30%). Other variables studied included: patient demographics, average hospital length of stay, and the types of nonoperative cervical fractures treated [Table 1, Figures 1 and 2]. The Miami J was by far the most common

Table 1: Patient data.		
	Number of patients	Total (%)
Gender		
Male	57	82.6
Female	36	52.2
Race		
Caucasian	57	82.6
American Indian	5	7.2
African American	5	7.2
Other	2	2.9
Age		
17-40	19	27.5
41-60	17	24.6
61-80	16	23.2
81-97	17	24.6
Length of stay		
1-3	37	53.6
4–7	22	31.9
8-10	5	7.2
11–20	3	4.3
21-40	2	2.9

orthotic used (n = 48, 71%), followed by Miami J and CTO (n = 11, 16%) [Figure 3]. Patients were cleared by an IRB committee and were selected utilizing multiple inclusion and exclusion criteria were used [Supplemental Table 1].

RESULTS

The study revealed that all patients had, on average, four follow-up visits occurred on average 28-, 66-, 94-, and 158day post hospital discharge [Supplemental Table 2]. The average time between hospital discharge and clearance from an orthotic was 70 days [Table 2]. At 28 days, X-rays performed in 57 patients impacted clinical decision-making in four; two with vertebral body fractures, one with a facet fracture, and one with a compression fracture [Table 2]. However, at the second postoperative visit at 66 days, the third visit at 94 days, and the fourth visit at 158 days, repeat X-ray studies did not alter the clinical management of any patient [Table 2]. Of note, the average time between hospital discharge and removal of an orthotic device averaged 70 days [Table 2].

DISCUSSION

This analysis of the nonoperative management of 69 adults confirmed that only their initial postoperative X-rays

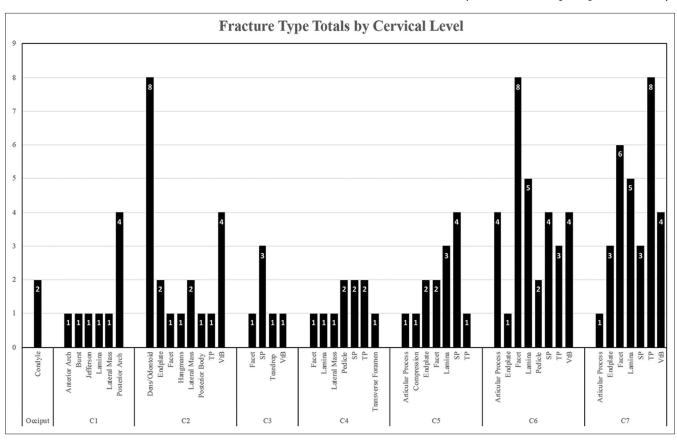


Figure 1: Fracture type totals by cervical level.

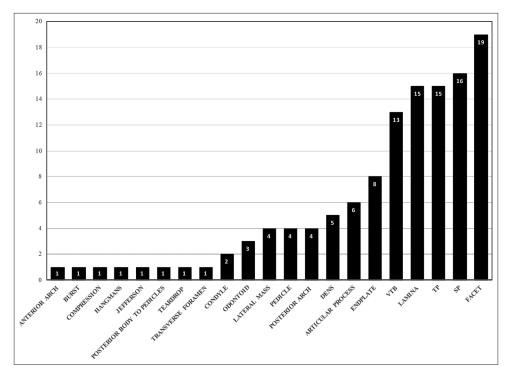


Figure 2: Number of fracture types.

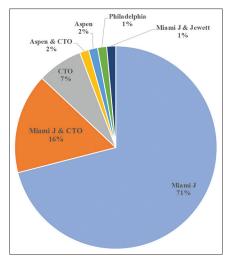


Figure 3: Orthotics used.

obtained at an average of 28-day post discharge impacted their clinical management. All subsequent X-rays obtained at an average of 66-, 94-, and 158-day post discharge did not. Therefore, repeating postoperative X-rays and exposing patients to additional radiation with prolongation of the follow-up period were all unnecessary.

Success of conservative management of C1-C2 fractures

Kontautas et al. and Hadley et al. found that isolated C1 fractures heal well with a cervical collar alone(95% fusion rate). [4,5] Type 1 fractures have been reported to achieve 100% union rates; however, Type 2 fractures are the most common and unfortunately present with high rates of pseudoarthrosis.^[4,6] For stable Type 3 fractures, conservative treatment is the standard of care due to high union rates [Table 3].^[1]

In our cohort, none the patients with isolated C1 fractures were followed beyond the second follow-up visit at 66-days, and further imaging never altered the clinical management. For isolated C2 fractures, our cohort consisted of 15 patients; managed with various orthoses with orthotic clearance on average 83-day post discharge [Figure 2]. In our cohort, only two patients had a change in intervention from imaging performed during the first follow-up, and only three were followed beyond the second appointment [Supplemental Table 2]. For the 12 patients with stable Type 3 fractures in our series, X-rays did not change management for any patient during follow-up period, with an average orthotic clearance of 89-day post discharge.

Conservative management of sub-axial fractures

Vedantam et al. reviewed 35 patients with sub-axial facet fractures managed non-operatively (cervical bracing alone) and 82.9% of patients fused successfully.^[7] Of our 56 patients with variable sub-axial fractures managed with various orthotics Eighteen patients (32%) with sub-axial facet fractures were cleared from the orthotic on average 60-day post discharge, or at the second follow-up.

Table 2:	Follow-up	information.
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Tubic 2. Tollow	up imormation.				
	Number of patients with imaging	Number of patients without imaging	Number of patients with changed intervention	Number of patients with insufficient information	Time from discharge to follow-up (days)
Follow-up #1	57	12	4	12	28
Follow-up #2	41	8	0	N/A	66
Follow-up #3	19	1	0	1	94
Follow-up #4	5	0	0	N/A	158

Table 3: Pertiner	nt literature	findings
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Table 3. 1 cm	ment incrature initings.
Author	Important findings
Kontautas	C1 fractures heal with cervical collar alone with 95% fusion rates
Hadley	Isolated C1 fractures in 32 patients, median follow-up of 40 days, with no nonunion of fracture or instability on flexion-extension X-ray Type 1 fractures reported to achieve 100% union rates
Oh	Type 2 fractures (most common) present with high rates of pseudoarthrosis Sub-axial fractures when isolated can be treated conservatively (lamina or transverse process)
Anderson	Type 3 (stable) fractures, standard of care is conservative treatment; high union rates
Vendantam	Cervical facet fractures, first follow-up at 2–4-week post discharge; follow-up period ranged 0.5–11.4 months. They found at first follow-up, 82.9% of patients had no new neurological deficits or spinal instability

Optimal follow-up for nonsurgical cervical fractures

At present, there are few recommendations regarding the optimal the number/types of imaging studies needed to follow patients with nonoperative cervical fractures and the optimal follow-up duration. Here, in 69 patients, we found that most will undergo a change in therapy/intervention based on X-ray studies obtained at the first follow-up visit, 28-day post discharge. Interestingly, no patients required additional alterations in management based on X-rays obtained on average 66-, 94-, and 158-day post discharge. Nonetheless, as patients typically had cervical orthoses removed an average of 70-day post discharge; the second follow-up visit was likely necessary.

CONCLUSION

When we studied 69 patients treated conservatively for nonoperative cervical spine fractures, we found that X-ray studies obtained on average 28-, 66-, 94-, and 158-day post discharge did not significantly alter patients' clinical management, but unnecessarily prolonged the follow-up duration.

Declaration of patient consent

Institutional Review Board (IRB) permission obtained for the study.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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SUPPLEMENTAL TABLES

Supplemental Table 1: Inclusion and exclusion criteria.

Inclusion and Exclusion Criteria

- One or more fractures involving the cervical spine
- One or more of the cervical fractures were managed nonoperatively
- Patients had sufficient follow-up and radiographic information from outpatient clinic records
- For patients with comorbid operative and non-operative fractures, only the nonoperative fracture and follow-up information concerning nonoperative management was collected
- Alteration of the intervention by prolongation of orthotic clearance was determined by imaging results and/or surgeon dictation
- Physical examination findings, patient presentation, operatively managed fractures, or other patient related factors were excluded from this assessment

Marche M	nental Table 2: Patient demographics, fra	Table 2: Patient demographics, fracture, but	Patient demographics, fracture, bu	mographics, fracture, b	racture, bı	ac	ing, and follov	v-up data.	,											
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§ 5 4 Male 2 HOME CTO MVC CT Lamina, 18 Y N 95 Y N 91 75 Male 2 HOME WM Minari Fall-Clan GG Lamina, 13 Y N 41 Y N 95 Y N 95 7.6 Fernale 1 HOME Minari Fall-Clan GG Lamina, 13 Y N 41 Y N 76 Y N 95 7.6 Fernale 1 HOME Minari Fall-SIM C1,C2 Jefferson, 28 Y N 60 Y N 76 Y N 102 2.2 Male 1 HOME Minari Fall-SIM C2 Odentsid 23 Y N 60 Y	83			HOME		MVC	C2	Odontoid		⊢			Z	94	>	Z				45	ORTHO
Find	85			HOME	CTO	MVC	C7	Lamina.		·			; Z	95	· >	; Z				39	ORTHO
91 75 Male 2 HOME w/main Main Fall clin GG Lamina 13 Y N 41 Y N 76 Y N 95 76 Fernalc 1 HOME Miami Fall clin C1, C2 Jefferson, 28 Y N 60 Y N 109 Y N 201 Y 97 17 Male 1 HOME Miami Fall clin C1, C2 Jefferson, Cardyle 20 Y N 60 Y N <td>}</td> <td></td> <td></td> <td></td> <td>)</td> <td>)</td> <td>j</td> <td>Endulate</td> <td></td> <td></td> <td><u>)</u></td> <td>•</td> <td></td> <td>,</td> <td>•</td> <td></td> <td></td> <td></td> <td></td> <td><u>`</u></td> <td></td>	}))	j	Endulate			<u>)</u>	•		,	•					<u>`</u>	
95 76 Fernale 1 HOME Maint Fall-lan C1, C2 Deferson, Defension 28 Y N 109 Y N 201 Y 97 17 Male 4 HOME Miami Fall-lan C1, C4 Arch 12 Y N 68 Y N 109 Y N 201 Y N 101 Y N 101 Y N 101 Y N 46 Y <	91			HOMF w/	Miami	Fall < 1m	90	Lamina		<u></u>	41	,- \	Z	92	>	2				4	ORTHO
95 76 Female 1 HOME Mismil Fall > Image CI, C2 Jefferson, 28 Y N 60 Y N 109 Y N 201 Y 97 17 Male 4 HOME Mismil Fall > Image CI, C2 Ordentiod 2 N N N N N N N N N N N N N N N N N N N N N N N N N N N N N N N N N N N N N N N N N N N N N N N N N N N N N N N N N N N N N N N N N N N N N N N N<	1/			home health	I CTO	THE .					11	•		2	•					1	
97 17 Male 4 HOME Mani Fall-lin Cl. Arch 12 Y N 68 Y N 101 Y N 68 Y N 101 Y N	95		1	HOME	Miami I	Fall >1m	()	Iaffarson		-			2	100	>	2	201	>	7	100	OPTHO
97 17 Male 4 HOME Miami Fall > Im C1 Arch 12 Y N 68 Y N Arch N N Arch N Arch N Arch N N Arch N N Arch N N Arch N Arch N N Arch N N Arch N <th< td=""><td>S</td><td></td><td>1 71</td><td>IIOME</td><td>MIGHH)</td><td>1 am / 11111</td><td>C1, C2</td><td>Odontoid</td><td></td><td>,</td><td></td><td></td><td>7</td><td>100</td><td>-</td><td>7</td><td>707</td><td>-</td><td>7-1</td><td>100</td><td>OIVIIIO</td></th<>	S		1 71	IIOME	MIGHH)	1 am / 11111	C1, C2	Odontoid		,			7	100	-	7	707	-	7-1	100	OIVIIIO
10 10 10 10 10 10 10 10	70			HOME	Miami	Fall >1m	5	Arch		-										Thhnown	NEC
102 52 Male 1 HOME Manial ATV G6 Other 40 Y N 68 Y N 103 24 Male 19 LTAC Miamil ATV G6 Other Condyle 21 Y N N 104 58 Male 1 HOME Miamil Fall>lm C1 C1 C1 C1 C1 C1 C1 C	3			IIOME	I CTO	1 an / 1111	5	Men		,										OIIMIOWII	CTAT
10.2 2.4 Mate 1 HOME Miamil MIV Cocjut Condylet 2.1 N N N N N N N N N	00			T) (OII), (10	7 T. 4	Č	170		F			1							Ç	O LL
103 24 Male 19 LIAC Miami ANC Occiput Condyte 21 Y N N N N N N N N N	102			HOME	Milami j	AIV	ق ک	Otner		7 '	99	ı	Z							80	INES
108 58 Male 1 HOME None Fall-lim C2 Odontoid 73 Y N 101 Y N 46 Y N 112 60 Male 1 HOME Miamij Fall-lim C3 TP, SP 8 Y N 46 Y N </td <td>103</td> <td></td> <td></td> <td>LIAC</td> <td>Miami J</td> <td>MVC</td> <td>Occiput</td> <td>Condyle</td> <td></td> <td>7</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>21</td> <td>NES</td>	103			LIAC	Miami J	MVC	Occiput	Condyle		7										21	NES
112 60 Male 1 HOME Miamij Fall > Im C1 Jefferson 7 Y N 14 Y N 46 Y N 91 Y 113 54 Female 2 HOME Miamij Fall > Im C3, C7 TP, SP 8 Y N N N N N N N N N	108			HOME	None	Fall >1m	C2	Odontoid		ワ			Z							101	ORTHO
113 54 Female 2 HOME Miamij Fall > Im C3, C7 TP, SP 8 Y N 95 Y N 144 Y N 207 Y Y 116 88 Female 9 NH/ITC Miamij Fall > Im C2 YB 46 Y N NA 86 N NA NA NA NA NA NA NA	112			HOME	Miami J	Fall >1m	C1	Jefferson		ワ			Z	46	Y	Z	91	Y	Z	91	ORTHO
116 88 Female 9 NH/ITC Miamij Fall>lm C2 VB 46 Y N 95 Y N 144 Y N 207 Y 118 71 Male 2	113			HOME	Miami J	Fall >1m	C3, C7	TP, SP												∞	ORTHO
118 71 Male 2 Miamij MVC C1, C4 Lateral Mass, 50 Y NA 86 N NA 120 67 Male 5 HOME Miamij MVC C1, C4 Lateral Mass, 50 Y N 93 Y N 122 77 Female 1 SNF None Fall < Im	116			NH/LTC	Miami J	Fall >1m	C2	VB		17			Z	144	Y	Z	207	Y	Z	207	NES
120 67 Male 5 HOME Miami J MVC C1, C4 Lateral Mass, TP 50 Y N 93 Y N 122 77 Female 1 SNF None Fall < Im	118				Miami J	MVC	C2	TP		IA.			NA							98	NES
122 77 Female 1 SNF None Fall < Im C2 Odontoid 14 N NA 124 26 Female 3 HOME Miamij Fall < Im	120			HOME	Miami J	MVC	C1, C4	Lateral Mass,		17			Z							93	NES
124 26 Female 1 SNF None Fall < Im								TP													
124 26 Female 3 HOME Miamij Fall < Im	122			SNF	None	Fall <1m	C2	Odontoid		IA.										14	ORTHO
128 74 Female 2 HOME Miamij Fall < Im C2, C3 Facet 54 Y N 84 Y N 129 62 Male 10 REHAB Miamij ATV C3 Bndplate 42 N NA 85 Y N 130 84 Male 4 HOME Miamij Miamij Miamij Fall < Im	124			HOME	None	Fall >1m	C7	Lamina		Ь										57	ORTHO
129 62 Male 5 HOME Miamij ATV C3 VB 18 Y N 76 Y N 130 84 Male 10 REHAB None Fall < Image	128			HOME	Miami J	Fall <1m	C2, C3	Facet		7			Z							84	NES
130 84 Male 10 REHAB None Fall < Image	129			HOME	Miami J	ATV	C3	VB		⊢	26	Y	Z							9/	NES
133 50 Male 4 HOME Miamij Miamij Fall < 1m				REHAB	None	Fall <1m	C7	Endplate		JA			Z							85	NES
136 96 Male 5 SNF Miami J Fall < 1m C2, 3, 4, 5, 6 VB, SP 14 Y N 49 Y N 142 86 Female 3 REHAB Miami J Fall < 1m				HOME	Miami J	MVC	C6, C7	$_{ m TP}$		17										54	NES
142 86 Female 3 REHAB Miami J Fall < 1m C2 Other 18 Y N 53 Y N 95 Y				SNF	Miami J	Fall <1m	C2,3,4,5,6	VB, SP		17			Z							Unknown	ORTHO
			<u>e</u>	REHAB	Miami J	Fall <1m	C2	Other		-			Z	95	Y	Z				53	ORTHO

Supplemental Table 2: (Continued).	ıtal Table	2: (Contin	ued).															
Record Age ID	Age Sex	Length of Stay (Days)	th Discharge ay Destination s)	а	Bracing Mechanism Device of Injury	Level of Injury	Type of Fracture	Days from Discharge to 1st FU	Imaging at 1st FU	Changed In tervention?	Days from Discharge to 2nd FU	Imaging Changed at 2 nd Intervent FU	Changed Intervention?	Days from Imaging Discharge at 3 rd FU to 3 rd FU	jing Changed FU Intervention?	Days from Imaging Changed Discharge at $4^{th} FU$ Intervention to $4^{th} FU$	Days from Service Discharge to Brace Clearance	Service
144	77 Female 57 Female	ale 1 ale 3	HOME	Miami J Miami J	Fall <1 m Assault	C1 C2, C6	Other Lateral Mass, Pedicle	27 50	Y	z z	85	Y	Z				Unknown 85	NES NES
154	55 Male	2	HOME	Miami I. CTO	MVC	C6, C7	Facet, Compression	32	Y	Z	89	¥	Z				89	NES
158 9	94 Female 49 Male	ale 1	NH/LTC HOME w/ home health	th	Fall <1m MVC	C3 C5,6,7	Other TP, Face, Lamina,	4 7	Y Y	zz	53 84	Z >	N N				53 Unknown	ORTHO
166	81 Female	ıle 3	HOME	Miami J	Fall < 1 m	Occiput,	Condyle, Lateral Mass	14	Y	Z	28	Z	NA	70 Y	Z		70	ORTHO
170 172 174 182	51 Male 32 Male 48 Male 35 Female	1 1 2 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	HOME HOME HOME REHAB	Miami J Miami J Miami J Miami J	MVC MVC ATV MVC	C7 C1 C4 C4	Facet, VB Arch Facet TP, Lamina, Pedicle, Transverse	8 43 41 36	*****	ZZZZ	76	* *	zz				Unknown 43 76 71	ORTHO NES NES NES
183 189 196	27 Female 29 Male 65 Female	ale 5 1 1 ale 4	HOME HOME HOME	Miami J Miami J Miami J	Fall > 1 m MVC Fall < 1 m	C6, C7 C6, C7 C5, C6	Foramen TP, VB Facet Compression, Other	13 14 37	X X X	Z Z >	41	X X	z z	А 06	z		90 14 77	ORTHO ORTHO NES