



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 occipitocervical and 91 sub-axial) cervical fractures; at least one of the cervical fractures was managed nonoperatively. Outcomes were assessed along with the optimal follow-up 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 ( $\pm 32.4$  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.<sup>[2,3]</sup> 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

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].

**Table 1:** Patient data.

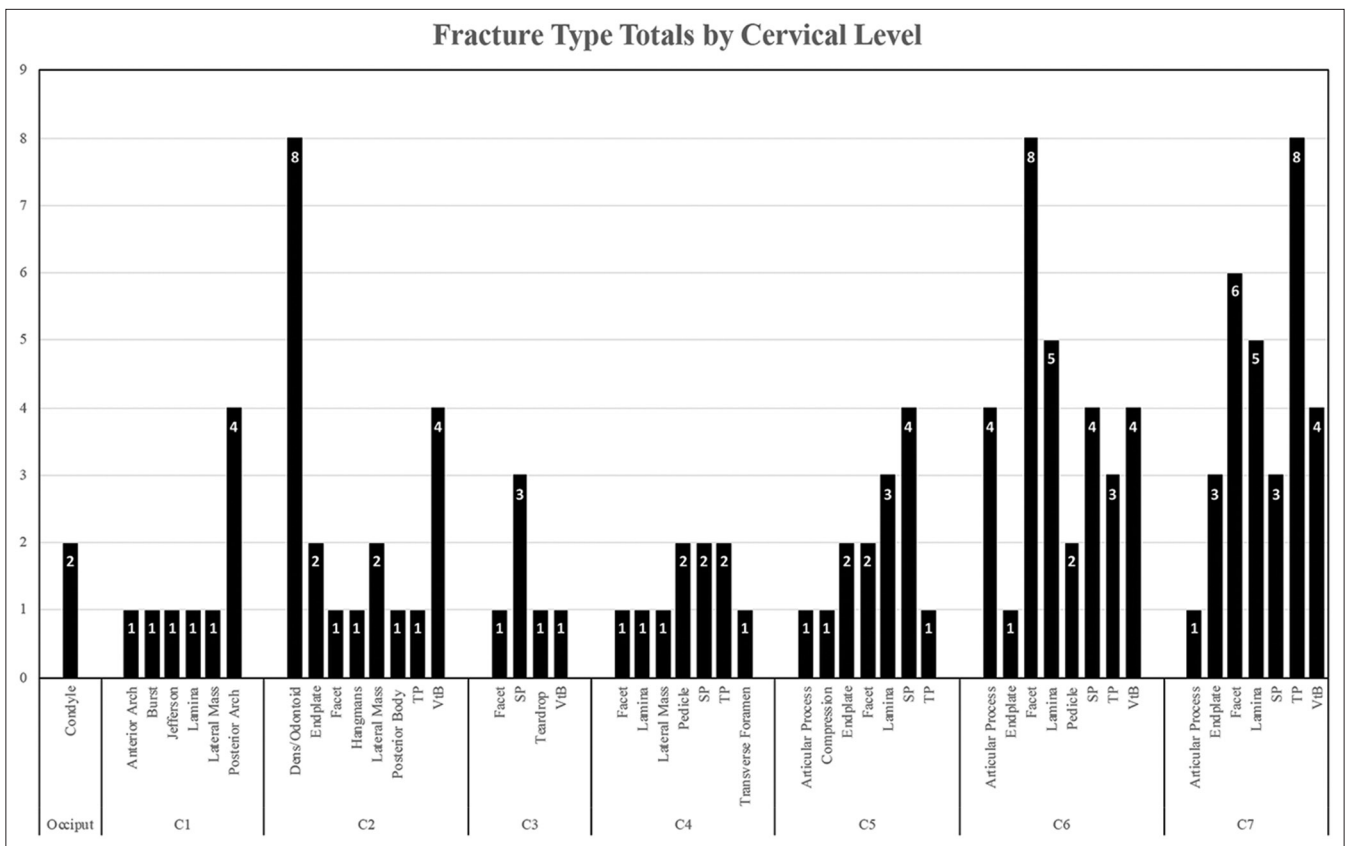
	Number of patients	Total (%)
Gender		
Male	57	82.6
Female	36	52.2
Race		
Caucasian	57	82.6
American Indian	5	7.2
African American	5	7.2
Other	2	2.9
Age		
17-40	19	27.5
41-60	17	24.6
61-80	16	23.2
81-97	17	24.6
Length of stay		
1-3	37	53.6
4-7	22	31.9
8-10	5	7.2
11-20	3	4.3
21-40	2	2.9

**RESULTS**

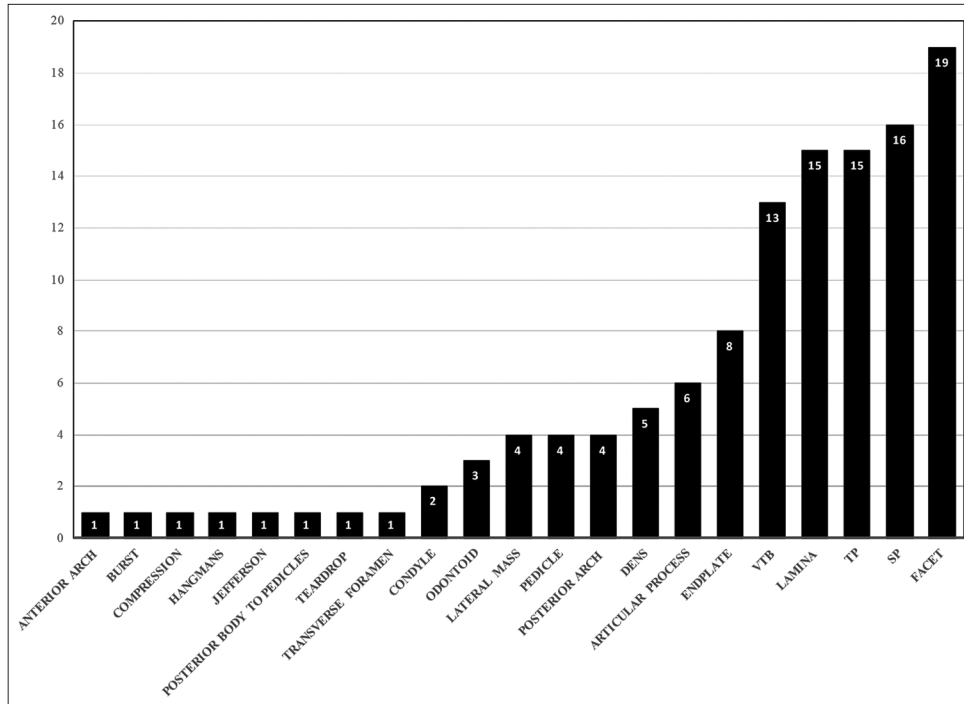
The study revealed that all patients had, on average, four follow-up visits occurred on average 28-, 66-, 94-, and 158-day post hospital discharge [Supplemental Table 2]. The average time between hospital discharge and clearance from an orthotic was 70 days [Table 2]. At 28 days, X-rays performed in 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**

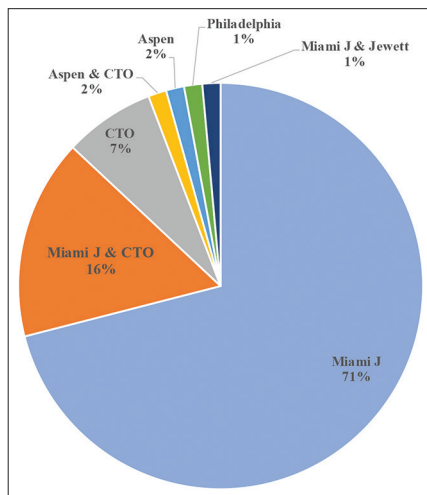
This analysis of the nonoperative management of 69 adults confirmed that only their initial postoperative X-rays



**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).<sup>[4,5]</sup> 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.<sup>[4,6]</sup> For stable Type 3 fractures, conservative treatment is the standard of care due to high union rates [Table 3].<sup>[1]</sup>

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.<sup>[7]</sup> 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.

	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:** Pertinent literature findings.

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
Oh	Type 1 fractures reported to achieve 100% union rates 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

Supplemental Table 2: Patient demographics, fracture, bracing, and follow-up data.

Record ID	Age	Sex	Length of Stay (Days)	Discharge Destination	Bracing Device	Mechanism of Injury	Level of Injury	Type of Fracture	Days from Discharge to 1 <sup>st</sup> FU	Imaging at 1 <sup>st</sup> FU	Changed In Intervention?	Days from Discharge to 2 <sup>nd</sup> FU	Imaging at 2 <sup>nd</sup> FU	Changed Intervention?	Days from Discharge to 3 <sup>rd</sup> FU	Imaging at 3 <sup>rd</sup> FU	Changed Intervention?	Days from Discharge to 4 <sup>th</sup> FU	Imaging at 4 <sup>th</sup> FU	Changed Intervention	Days from Discharge to Brace Clearance	Service
2	20	Male	2	HOME	Miami J	MVC	C6, C7	Facet, Lamina	42	Y	N	60	Y	N	92	Y	N	92			92	NES
9	79	Female	15	SNF	Miami J, CTO	Fall <1m	C1, C5	SP, Lamina	39	Y	N										Unknown	NES
11	83	Female	3	REHAB	Miami J	Fall <1m	C2	Odontoid	15	Y	N	57	Y	N	99	Y	N				99	ORTHO
12	31	Female	6	HOME	None	MVC	C6, C7	TP	21	N	NA										21	ORTHO
14	88	Female	4	SNF	Miami J	Fall >1m	C2, C6	Odontoid, arch	8	Y	N	50	Y	N	99	Y	N				99	ORTHO
17	17	Female	35	LTAC	Miami J, CTO	MVC	C2	Odontoid	13	Y	N	41	Y	N							41	ORTHO
18	46	Male	8	HOME	CTO	ATV	C5, C6	Facet, VB, Lamina	16	Y	N	72	Y	N							72	ORTHO
22	53	Female	5	REHAB	Miami J, CTO	MVC	C5	Facet	26	Y	Y	54	Y	N	82	Y	N				82	NES
23	19	Female	2	HOME	Miami J	MVC	Occiput, C7	TP	20	N	NA										Unknown	ORTHO
25	70	Male	2	HOME	Miami J, CTO	Fall <1m	C5, C6	SP, Lamina	30	N	N										Unknown	NES
30	67	Male	1	HOME	None	Fall <1m	C6	VB	4	Y	N										Unknown	ORTHO
31	83	Male	5	REHAB	CTO	MVC	C7	VB	35	Y	Y	77	N	NA							77	ORTHO
32	83	Male	2	REHAB	Miami J	Fall >1m	C3,4,5,6,7	SP, Lamina	80	Y	N										80	ORTHO
34	53	Male	6	HOME	Aspen	MVC	C5	Lamina	14	Y	N	63	Y	N	105	Y	N				63	ORTHO
35	70	Female	7	SNF	Miami J	Fall >1m	C7	Other	18	N	NA	98	Y	N							Unknown	NES
36	17	Female	1	HOME	Miami J	MVC	C7	TP	5	N	NA	38	N	NA							38	ORTHO
37	38	Male	15	REHAB	Miami J, Jewett	ATV	C6	Facet	73	Y	N	171	Y	N							73	NES
39	86	Female	4	REHAB	Miami J	Fall <1m	C2	Odontoid	19	N	NA	64	Y	N	106	Y	N				106	ORTHO
40	65	Male	1	HOME w/ supervision	Miami J	Fall <1m	C6, C7	Facet	19	Y	Y	40	Y	N	68	Y	N	110	Y	N	110	NES
41	85	Female	5	REHAB	Miami J, CTO	Fall <1m	C1	Arch	29	Y	NA										Unknown	NES
42	82	Male	1	HOME	Miami J	MVC	C6	VB	34	Y	N	83	Y	N							83	NES
43	88	Female	2	HOME w/ supervision	Miami J	Fall <1m	C2	Odontoid	14	Y	N										Unknown	ORTHO
49	63	Female	1	HOME	Miami J	MVC	C2, C5	Other	11	N	NA	53	N	NA							53	ORTHO
50	59	Female	5	REHAB	Miami J, CTO	ATV	C6	Facet, Lamina	9	N	NA	37	Y	N							37	ORTHO
54	20	Female	30	REHAB	Miami J	MVC	C2	Odontoid	47	Y	N	124	N	NA							124	BOTH
56	36	Female	5	HOME	Miami J	MVC	C2	Endplate	14	Y	N	42	Y	N							42	ORTHO

(Contd...)

Supplemental Table 2: (Continued).

Record ID	Age	Sex	Length of Stay (Days)	Discharge Destination	Bracing Device	Mechanism of Injury	Level of Injury	Type of Fracture	Days from Discharge to 1 <sup>st</sup> FU	Imaging at 1 <sup>st</sup> FU	Changed Intervention?	Days from Discharge to 2 <sup>nd</sup> FU	Imaging at 2 <sup>nd</sup> FU	Changed Intervention?	Days from Discharge to 3 <sup>rd</sup> FU	Imaging at 3 <sup>rd</sup> FU	Changed Intervention?	Days from Discharge to 4 <sup>th</sup> FU	Imaging at 4 <sup>th</sup> FU	Changed Intervention?	Days from Discharge to Brace Clearance	Service	
57	22	Female	9	HOME	Miami J, CTO	MVC	Occiput, C2	VB, Endplate	32	Y	N	60	Y	N	81	Y	N	81	Y	N	81	NES	
60	88	Female	1	HOME	Miami J	Fall <1m	C2	Odontoid	5	Y	N	48	Y	N	89	Y	N	180	Y	N	99	ORTHO	
61	56	Male	2	HOME	Miami J	Fall >1m	C7	TP	29	Y	N	50	Y	N	80	Y	N				50	NES	
66	27	Male	5	HOME	Miami J, CTO	ATV	Occiput, C7	Facet, VB, SP, Lamina	45	Y	N	80	Y	N								80	NES
67	63	Male	8	HOME	Miami J	ATV	C2	Odontoid	34	Y	N	79	Y	N							Unknown	ORTHO	
70	90	Female	1	HOME w/ home health	Miami J	Fall <1m	C5	SP, Lamina	17	N	NA										Unknown	ORTHO	
71	97	Female	4	SNF	Miami J	Fall <1m	C2	Odontoid	30	Y	N	61	N	NA	152	N	NA				61	ORTHO	
77	40	Female	1	HOME	Miami J	MVC	C5,6,7	Other, Endplate	37	Y	N	72	Y	N							72	NES	
80	45	Female	5	HOME	Miami J	MVC	C5,6,7	TP, SP	66	Y	N										66	NES	
83	36	Male	1	HOME	CTO	MVC	C2	Odontoid	10	Y	N	45	Y	N	94	Y	N				45	ORTHO	
85	54	Male	2	HOME	CTO	MVC	C7	Lamina, Endplate	18	Y	N	39	Y	N	95	Y	N				39	ORTHO	
91	75	Male	2	HOME w/ home health	Miami J	Fall <1m	C6	Lamina	13	Y	N	41	Y	N	76	Y	N				41	ORTHO	
95	76	Female	1	HOME	Miami J	Fall >1m	C1, C2	Jefferson, Odontoid	28	Y	N	60	Y	N	109	Y	N	201	Y	N	109	ORTHO	
97	17	Male	4	HOME	Miami J, CTO	Fall >1m	C1	Arch	12	Y	N										Unknown	NES	
102	52	Male	1	HOME	Miami J	ATV	C6	Other	40	Y	N	68	Y	N							68	NES	
103	24	Male	19	LTAC	Miami J	MVC	Occiput	Condyle	21	Y	N										21	NES	
108	58	Male	1	HOME	None	Fall >1m	C2	Odontoid	73	Y	N	101	Y	N							101	ORTHO	
112	60	Male	1	HOME	Miami J	Fall >1m	C1	Jefferson	7	Y	N	14	Y	N	46	Y	N	91	Y	N	91	ORTHO	
113	54	Female	2	HOME	Miami J	Fall >1m	C3, C7	TP, SP	8	Y	N										8	ORTHO	
116	88	Female	9	NH/LTC	Miami J	Fall >1m	C2	VB	46	Y	N	95	Y	N	144	Y	N	207	Y	N	207	NES	
118	71	Male	2	HOME	Miami J	MVC	C2	TP	51	N	NA	86	N	NA							86	NES	
120	67	Male	5	HOME	Miami J	MVC	C1, C4	Lateral Mass, TP	50	Y	N	93	Y	N							93	NES	
122	77	Female	1	SNF	None	Fall <1m	C2	Odontoid	14	N	NA										14	ORTHO	
124	26	Female	3	HOME	None	Fall >1m	C7	Lamina	57	Y	N										57	ORTHO	
128	74	Female	2	HOME	Miami J	Fall <1m	C2, C3	Facet	54	Y	N	84	Y	N							84	NES	
129	62	Male	5	HOME	Miami J	ATV	C3	VB	18	Y	N	76	Y	N							76	NES	
130	84	Male	10	REHAB	None	Fall <1m	C7	Endplate	42	N	NA	85	Y	N							85	NES	
133	50	Male	4	HOME	Miami J	MVC	C6, C7	TP	44	Y	N										54	NES	
136	96	Male	5	SNF	Miami J	Fall <1m	C2,3,4,5,6	VB, SP	14	Y	N	49	Y	N	95	Y	N	Unknown			Unknown	ORTHO	
142	86	Female	3	REHAB	Miami J	Fall <1m	C2	Other	18	Y	N	53	Y	N							53	ORTHO	

(Contd...)

Supplemental Table 2: (Continued).

Record ID	Age	Sex	Length of Stay (Days)	Discharge Destination	Bracing Device	Mechanism of Injury	Level of Injury	Type of Fracture	Days from Discharge to 1 <sup>st</sup> FU	Imaging at 1 <sup>st</sup> FU	Changed In Intervention?	Days from Discharge to 2 <sup>nd</sup> FU	Imaging at 2 <sup>nd</sup> FU	Changed Intervention?	Days from Discharge to 3 <sup>rd</sup> FU	Imaging at 3 <sup>rd</sup> FU	Changed Intervention?	Days from Discharge to 4 <sup>th</sup> FU	Imaging at 4 <sup>th</sup> FU	Changed Intervention?	Days from Discharge to Brace Clearance	Service	
144	77	Female	1	HOME	Miami J	Fall <1m	C1	Other	27	Y	N										Unknown	NES	
149	57	Female	3	HOME	Miami J	Assault	C2, C6	Lateral Mass, Pedicle	50	Y	N	85	Y	N								85	NES
154	55	Male	2	HOME	Miami J, CTO	MVC	C6, C7	Facet, Compression	32	Y	N	68	Y	N								68	NES
158	94	Female	1	NH/LTC	Miami J	Fall <1m	C3	Other	4	Y	N	53	N	NA								53	ORTHO
161	49	Male	6	HOME w/ home health	Aspen, CTO	MVC	C5,6,7	TP, Face, Lamina, Other	7	Y	N	84	Y	N								Unknown	ORTHO
166	81	Female	3	HOME	Miami J	Fall <1m	Occiput, C1, C4	Condyle, Lateral Mass	14	Y	N	28	N	NA	70	Y	N					70	ORTHO
170	51	Male	1	HOME	Miami J	MVC	C7	Facet, VB	8	Y	N											Unknown	ORTHO
172	32	Male	1	HOME	Miami J	MVC	C1	Arch	43	Y	N											43	NES
174	48	Male	2	HOME	Miami J	ATV	C4	Facet	41	Y	N	76	Y	N								76	NES
182	35	Female	4	REHAB	Miami J	MVC	C4	TP, Lamina, Pedicle, Transverse Foramen	36	Y	N	71	Y	N								71	NES
183	27	Female	5	HOME	Miami J	Fall >1m	C6, C7	TP, VB	13	Y	N	41	Y	N	90	Y	N					90	ORTHO
189	29	Male	1	HOME	Miami J	MVC	C6, C7	Facet	14	Y	N											14	ORTHO
196	65	Female	4	HOME	Miami J	Fall <1m	C5, C6	Compression, Other	37	Y	Y	77	Y	N								77	NES