

# An Update on Management of Syndesmosis Injury: A National US Database Study

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## Abstract

We conducted a study to determine the incidence of syndesmotic injury and stabilization within various ankle fracture patterns along with the rate of syndesmotic implant removal.

All data were obtained from a publicly available for-fee healthcare database, the PearlDiver Patient Records Database. *Current Procedural Terminology (CPT)* codes were used to search the database for cases of fixation of lateral malleolus, bimalleolar, and trimalleolar fractures in addition to syndesmotic fixation and implant removal.

Open reduction and internal fixation

(ORIF) was performed for an ankle injury in 54,767 patients during 2007 to 2011. Total number of ORIF procedures was higher with each decade of life: 3206 cases in patients younger than 20 years, and 10,609 cases in patients 70 to 79 years old. Frequency of syndesmotic fixation increased significantly with ORIF of all ankle fractures ( $P < .0001$ ). Hardware removal decreased throughout the study period.

Incidence of syndesmotic injuries and rate of operative management trended upward over the study period, and rate of hardware removal decreased.

**A**cute ankle injuries are common problems treated by orthopedic surgeons. In the United States, nearly 2 million ankle sprains occur each year,<sup>1</sup> and ankle fractures account for 9% to 18% of all fractures treated in emergency departments.<sup>2,3</sup> Ankle injuries that involve the syndesmotic ligaments may result in instability and require specific treatment beyond fixation of the malleolar fractures.

The usual mechanism of syndesmotic injury is external rotation of the ankle with hyperdorsiflexion of a pronated or supinated foot.<sup>4,5</sup> Syndesmotic injuries are estimated to occur in up to 10% of ankle sprains<sup>6</sup> and up to 23% of all ankle fractures.<sup>7</sup> Overall US incidence of syndesmotic injury is estimated at 6445 injuries per year.<sup>8</sup> Syndesmotic injury occurs in 39% to 45% of supination-external rotation IV ankle fractures.<sup>9,10</sup> Pronation-external rotation ankle fractures have the highest rate of syndesmotic injury. Syndesmotic injury may be less common in other types of malleolar fracture, but the exact incidence has not been reliably reported.

Traditionally, isolated nondisplaced syndesmotic injuries are treated nonoperatively, and syndesmotic injuries with concomitant malleolar fractures are treated surgically. Various options are available for syndesmotic fixation. The gold standard is syndesmotic screw placement from the lateral aspect of the fibula through the tibia. Fixation may be achieved with screws in a variety of configurations and formats. However, fixation with two 4.5-mm screws is stronger.<sup>11,12</sup> Functional outcomes are similar, regardless of screw material,<sup>13-16</sup> number of cortices,<sup>17</sup> or number of screws.<sup>18</sup> Disadvantages specific to screw fixation include altered ankle biomechanics,<sup>19,20</sup> potential for screw breakage,<sup>21</sup> and need for implant removal.<sup>3</sup>

Alternatively, suture button fixation is said to be equally as effective as screw fixation in achieving syndesmotic reduction, and their functional outcomes are similar.<sup>22,23</sup> The initial cost of suture button fixation is higher than that of screw fixation, but the difference may be offset by potential elimination of a second surgery for syndesmotic

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screw removal.<sup>24</sup> Soft-tissue irritation caused by the suture material and local osteolysis are reported complications of suture button fixation.<sup>25-27</sup>

Regardless of fixation method used, achieving anatomical reduction of the syndesmosis is considered the most important factor in optimizing functional outcomes.<sup>28-31</sup> However, achieving and verifying anatomical reduction of the syndesmosis during surgery can be quite challenging.<sup>30,32-34</sup> Various methods of lowering the malreduction risk, including direct visualization of the tibiofibular joint during reduction<sup>30,35</sup> and intraoperative 3-dimensional imaging,<sup>33,36</sup> have been proposed.

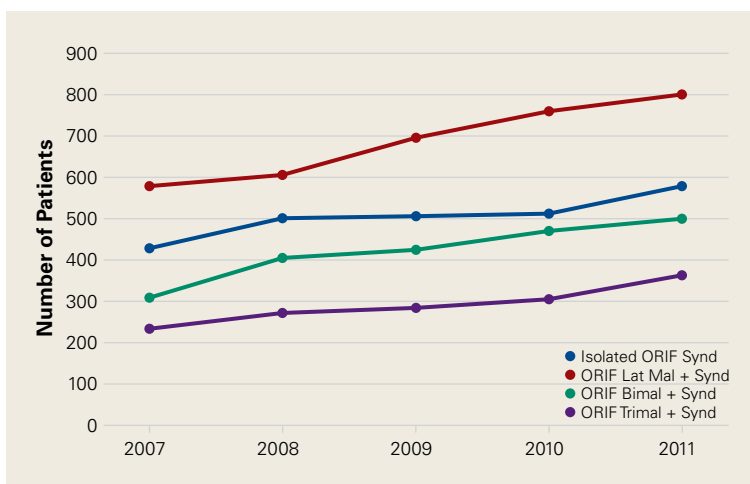
In the study reported here, we used a US insurance database to determine the incidence and rate of syndesmotic stabilization within various ankle injuries and fracture patterns.

### Materials and Methods

All data for this study were obtained from a publicly available for-fee healthcare database, the PearlDiver Patient Records Database, which includes procedural volumes and demographic information for patients with *International Classification of Diseases, Ninth Revision (ICD-9)* diagnoses and procedures or *Current Procedural Terminology (CPT)* codes. Data for the study were derived from 2 databases within PearlDiver: a private-payer database, which has its largest contribution (>30 million individual patient records for 2007-2011) from United HealthCare, and a Medicare database (>50 million patient records for 2007-2011). Access to the database was granted by PearlDiver Technologies for the purpose of academic research. The database was stored on a password-protected server maintained by PearlDiver.

We searched the database for cases of ankle fracture fixation, including fixation of isolated lateral malleolus (CPT 27792), bimalleolar (CPT 27814), and trimalleolar (CPTs 27822 and 27823) fractures. CPT 27829 was used to search for syndesmotic fixation, and CPT 20680 for implant removal. These codes were used individually and in combination.

Overall procedural volume data are reported as number of patients with the given CPT(s) in the database output and as incidence, calculated as number of patients with the CPT of interest normalized to total number of patients in the database for that particular subgroup. Results of age group and sex analyses are reported as number of patients reported in the database output and as percentage of patients who had the CPT procedure of interest that year. As United HealthCare is



**Figure.** Incidence by year of syndesmotic injury occurring in isolation (blue) or with lateral malleolus fracture (red), bimalleolar fracture (green), and trimalleolar fracture (purple).

Abbreviation: ORIF, open reduction and internal fixation.

the largest contributor to the private-payer portion of the database and is represented most prominently in the southern region, data for the regional analysis are presented only as incidence. This incidence was calculated as number of patients in a particular region and year normalized to total number of patients in the database for that region or year. The regions were Midwest (IA, IL, IN, KS, MI, MN, MO, ND, NE, OH, SD, WI), Northeast (CT, MA, ME, NH, NJ, NY, PA, RI, VT), South (AL, AR, DC, DE, FL, GA, KY, LA, MD, MI, NC, OK, SC, TN, TX, VA, WV), and West (AK, AZ, CA, CO, HI, ID, MT, NM, NV, OR, UT, WA, WY).

Chi-square linear-by-linear association analysis was used to determine the statistical significance of time trends in procedural volume, sex, age group, and region. For all statistical comparisons,  $P < .05$  was considered significant.

### Results

Number of open reduction and internal fixation (ORIF) procedures increased for all ankle fracture types over the period 2007 to 2011 (Table 1). Over the same period, number of procedures for isolated syndesmosis ORIF increased significantly ( $P = .045$ ), by 18%, and the rate of syndesmotic fixation with ORIF of ankle fracture significantly increased for all ankle fracture types ( $P$ s  $< .0001$  for ORIF of lateral malleolus, bimalleolar, and trimalleolar fractures) (Figure). The largest percentage change (43%) was in the rate of syndesmotic fixation with ORIF of a bimalleolar ankle fracture. The rate of implant removal after syndesmotic fixation sig-

**Table 1. Ankle Fracture and Syndesmosis ORIF Incidence<sup>a</sup>**

	Year					% Change	P
	2007	2008	2009	2010	2011		
<b>Ankle Fracture Fixation</b>							<b>2007-2011</b>
ORIF lateral malleolus	3958 (36.6%)	4060 (36.7%)	4202 (37.4%)	4459 (37.6%)	4555 (36.9%)	0.7%	.305
ORIF bimalleolar	3992 (37.0%)	4111 (37.1%)	4081 (36.3%)	4332 (36.6%)	4458 (36.1%)	-2.2%	.120
ORIF trimalleolar	2421 (22.4%)	2403 (21.7%)	2447 (21.8%)	2542 (21.5%)	2746 (22.3%)	-0.7%	.702
Isolated ORIF syndesmosis	431 (4.0%)	503 (4.5%)	509 (4.5%)	513 (4.3%)	581 (4.7%)	18.0%	.045
<i>Total</i>	10,802	11,077	11,239	11,846	12,340		
<b>Syndesmotic Fixation</b>							<b>2007-2011</b>
ORIF lateral malleolus + synd	581 (14.7%)	608 (15.0%)	696 (16.6%)	762 (17.1%)	805 (17.7%)	20.4%	<.0001
ORIF bimalleolar + synd	313 (7.8%)	409 (9.9%)	428 (10.5%)	473 (10.9%)	500 (11.2%)	43.0%	<.0001
ORIF trimalleolar + synd	235 (9.7%)	274 (11.4%)	287 (11.7%)	307 (12.1%)	368 (13.4%)	38.1%	<.0001
<b>Hardware Removal</b>							<b>2007-2010</b>
Isolated ORIF syndesmosis	138 (39.4%)	170 (41.3%)	183 (38.5%)	141 (32.2%)	—	-18.4%	.028
Lateral malleolus + synd	229 (41.9%)	251 (33.5%)	268 (39.3%)	245 (28.1%)	—	-32.8%	.002
Bimalleolar + synd	131 (40.0%)	137 (39.1%)	168 (37.3%)	133 (28.7%)	—	-28.3%	.001
Trimalleolar + synd	94 (32.0%)	107 (33.8%)	107 (36.0%)	88 (27.5%)	—	-14.2%	.004

<sup>a</sup>P < .05 was considered statistically significant.

Abbreviation: ORIF, open reduction and internal fixation; synd, syndesmosis.

nificantly decreased for all types of ankle fracture, including those that required only syndesmotic fixation. The largest percentage decrease (32.8%) in implant removal was in the rate of ORIF of a lateral malleolus fracture with syndesmotic fixation ( $P = .002$ ).

ORIF was performed for an ankle injury in 54,767 patients during the period 2007 to 2011, resulting in a cumulative incidence of 64.2 per 1000 patients (Table 2). Total number of ankle ORIF procedures increased with each decade of life until age 80 years. Incidence of ankle ORIF was highest for patients 20 years old to 29 years old (151.6/1000 patients). Incidence notably decreased in patients 60 years old to 69 years old (69.1/1000 patients) compared with patients 50 years old to 59 years old (149.5/1000 patients). Lateral malleolus fractures were the most common ankle fractures for every age group until the 50 to 59 year decade, at which point bimalleolar fractures became most common. In all age groups, trimalleolar fractures were the least common ankle fractures.

More ankle ORIF procedures were performed in females (33,565) than in males (21,202); incidence of ankle ORIF procedures was higher in females (68.6/1000 patients) than in males (58.4/1000 patients) (Table 2); percentages of bimalleolar and trimalleolar fractures were higher in females (bi, 40.6%; tri, 27.8%) than in males (bi, 34.6%; tri,

15.2%); and percentage of lateral malleolus fractures was higher in males (50.2%) than in females (31.6%).

Incidence of ankle ORIF procedures was similar in the South (69.6/1000 patients), Midwest (69.4/1000 patients), and West (65.1/1000 patients) but lower in the Northeast (43.3/1000 patients) (Table 2). Lateral malleolus fractures were the most common ankle fractures in the Midwest (40.7%) and West (41.3%), followed by bimalleolar fractures (Midwest, 36.3%; West 36.0%) and trimalleolar fractures (Midwest, 23.0%; West, 22.7%). Bimalleolar fractures were most common in the Northeast (40.2%) and South (39.8%), followed by lateral malleolus fractures (Northeast, 34.4%; South, 38.0%) and trimalleolar fractures (Northeast, 25.4%; South, 22.3%).

## Discussion

The present study found no significant change in number of lateral malleolus, bimalleolar, and trimalleolar ankle fracture ORIF procedures performed over the period 2007 to 2011. However, over the same period, incidence of syndesmosis fixation increased significantly in patients with isolated syndesmotic injuries and in patients with concomitant ankle fracture and syndesmotic injury. The largest percentage change was found in the bimalleolar ORIF group, which showed nearly a doubling of syndesmotic fixation over the 4-year

Table 2. Age, Sex, and Regional Distribution of Ankle Fracture Fixation

	Patients in Database	Fracture Fixation								P
		Ankle ORIFs		Lateral Malleolus		Bimalleolar		Trimalleolar		
		N	Incidence	Incidence	%	Incidence	%	Incidence	%	
<b>Age Group, y</b>										
<20	4,954,500	3206	64.7	33.6	52.0	23.7	36.6	7.4	11.4	
20-29	2,903,224	4401	151.6	73.8	48.7	52.2	34.4	25.6	16.9	
30-39	4,215,710	5070	120.3	53.6	44.6	40.5	33.7	26.2	21.8	
40-49	5,248,321	6946	132.3	56.8	42.9	44.8	33.9	30.7	23.2	
50-59	5,462,961	8167	149.5	54.2	36.2	54.2	36.3	41.1	27.5	
60-69	18,133,765	12,537	69.1	24.4	35.4	26.9	38.9	17.8	25.8	
70-79	25,935,119	10,609	40.9	14.5	35.4	17.1	41.9	9.3	22.8	
≥80	18,397,911	3831	20.8	5.7	27.3	10.6	50.8	4.5	21.6	
Total	85,251,511	54,767	64.2	24.9	38.8	24.6	38.3	14.7	22.9	<.0001
<b>Sex</b>										
Female	48,923,302	33,565	68.6	21.7	31.6	27.9	40.6	19.1	27.8	
Male	36,328,209	21,202	58.4	29.3	50.2	20.2	34.6	8.9	15.2	
Total	85,251,511	54,767	64.2	24.9	38.8	24.6	38.3	14.7	22.9	<.0001
<b>Region</b>										
Midwest	21,631,420	15,007	69.4	28.2	40.7	25.2	36.3	16.0	23.0	
Northeast	14,729,371	6375	43.3	14.9	34.4	17.4	40.2	11.0	25.4	
South	34,556,604	24,053	69.6	26.4	38.0	27.7	39.8	15.5	22.3	
West	14,334,116	9332	65.1	26.9	41.3	23.5	36.0	14.8	22.7	
Total	85,251,511	54,767	64.2	24.9	38.8	24.6	38.3	14.7	22.9	<.0001

Abbreviation: ORIF, open reduction and internal fixation.

study period, followed by a 38.1% increase in syndesmotom fixation in the trimalleolar ORIF group. Both groups had a syndesmotom fixation percentage change about twice that seen in the isolated lateral malleolus group.

There are several explanations for these trends. First, bimalleolar and trimalleolar fractures are more severe ankle fractures that tend to result from a more forceful mechanism, allowing for a higher rate of syndesmotom injury. Second, these trends likely do not reflect a true increase in the rate of syndesmotom injury but, rather, increased recognition of syndesmotom injury. Third, the data likely reflect a well-established approach to ankle fracture fixation and an increase in thinking that syndesmotom injuries should be stabilized in the setting of ankle fixation.

Incidence of syndesmotom injury as indicated by stabilization procedures can be compared with the data of Vosseller and colleagues,<sup>8</sup> who reported an incidence of 6445 syndesmotom injuries per year in the United States. Our data showed fewer syndesmotom injuries, which may be related to use of CPT codes rather than ICD-9 codes for database

searches, such that only operative syndesmotom injuries are represented in our data. Population differences between the 2 studies could also account for some of the differences in syndesmotom injury incidence.

We also found a significant change in the rate of hardware removal after syndesmotom ORIF. Across all treatment groups, incidence of screw removal decreased—a trend likely reflecting a change in attitude about the need for routine screw removal. Studies have shown that patients have favorable outcomes in the setting of syndesmotom screw loosening and screw breakage.<sup>37</sup> Some authors have suggested that screw breakage or removal could be advantageous, as it allows the syndesmotom to settle into a more anatomical position after imperfect reduction.<sup>38</sup> In addition, the trend of decreased syndesmotom screw removal could also have resulted from increased suture button fixation, which may less frequently require implant removal. Regardless, the overall trend is that routine syndesmotom implant removal has become less common.

This study had several limitations. First are the

many limitations inherent to all studies that use large administrative databases, such as PearlDiver. The power of analysis depends on data quality; potential sources of error include accuracy of billing codes and physicians' miscoding or noncoding. Although we tried to accurately represent a large population of interest through use of this database, we cannot be sure that the database represents a true cross-section of the United States. In addition, as we could not determine the method of syndesmosis fixation—the same CPT code is used for both suture button fixation and screw fixation—we could not establish trends for the rate of each method. More research is needed to establish these trends, and this research likely will require analysis of data from a large trauma center or from multiple centers.

Potential regional differences are another limitation. In the PearlDiver database, the South and Midwest are highly represented, the Northeast and West much less so. The South, Midwest, and West (but not the Northeast) had similar overall incidence and subgroup incidence of ankle ORIF. However, any regional differences in the rate of syndesmosis fixation could have skewed our data.

Ankle fractures and associated syndesmosis injuries remain a common problem. Although the prevalence of ankle fracture fixation has been relatively constant, the rate of syndesmosis stabilization has increased significantly. Young adults have the highest incidence of ankle fracture and associated syndesmosis fixation, but more ankle fractures occur in the large and growing elderly population. Increased awareness of syndesmosis injury likely has contributed to the recent rise in syndesmosis fixation seen in the present study. Given this trend, we recommend further analysis of outcome data and to establish treatment guidelines.

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*This paper will be judged for the Resident Writer's Award.*