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Original Article

Epidemiology, costs, and management trends of lateral ankle ligament injury

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Abstract

Objective: This study primarily aimed to determine the incidence of patients diagnosed with lateral ankle sprain who ultimately progressed to operative treatment. Secondary study aims included determining the implementation and costs of physical therapy (PT), ankle bracing, and NSAIDs generated by the treatment of an ankle sprain diagnosis.

Methods: Data were collected using the Pearl Diver Humana dataset using ICD-9, ICD-10, and CPT codes pertaining to ankle sprain, ligament repair or reconstruction, physical therapy, ankle brace, and NSAIDs. Patients were categorized into nonoperative treatment, operative repair, and operative reconstruction. Incidence, cost, and PT attendance were compared among the three groups.

Results: A total of 309,670 patients who sustained a lateral ankle sprain between 2007 and 2017 were identified. Of the patients, 306,180 (99%; 306,180/309,670) completed nonoperative management, and 2,774 (1%; 2,774/309,670) underwent operative intervention. Of the nonoperative management patients, 63,276 (21%; 63,276/306,180) received PT. Of the operative management patients, 1,536 (55%; 1,536/2,774) received PT pre-operatively and/or post-operatively. The mean total cost was $923.32 for nonoperative management, $3,384.63 for operative repair, and $3,659.98 for operative reconstruction.

Conclusions: Within orthopedics, there are different treatments for lateral ankle ligament sprains. This study demonstrates that most patients with lateral ankle ligament sprains do not require operative intervention, as 99% of patients completed nonoperative management. Patients treated nonoperatively attended fewer PT visits and generated lower costs than patients who underwent operative repair or reconstruction. Only 20% of nonoperative patients received PT.

Level of evidence III; Retrospective observational cohort study.

Keywords: Ankle; Sprain; Cost; Epidemiology; Injury.

Introduction

Lateral ankle sprains represent one of the most common musculoskeletal injuries in the general and athletic populations[1-4]. A previous study looking at the epidemiology of ankle sprains in the United States found that ankle sprains occurred at a rate of 2.5 per 1,000 person-years, with nearly half occurring during athletic activities[5]. Most patients will recover through conservative treatment. However, some patients progressively develop chronic ankle instability, defined as persistent lateral ankle instability and pain for over six months[2,4,6,7].

Additionally, it is important to consider that patients with a history of a single ankle sprain are at higher risk of sustaining a future sprain, as sprains often recur[8]. Lateral ankle ligament injury has been shown to have a high socioeconomic burden not only due to injury frequency but also the chronic sequelae associated with an ankle injury, including long-term health consequences[4,7,9,10]. Chronic lateral ankle instability may

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result in laxity, chronic pain, early-onset ankle osteoarthritis, and, ultimately, decreased quality of life[9]. Operative treatment to restore ankle stability is indicated for patients who have chronic lateral ankle instability with a failure to respond to conservative treatment[11]. Although operative treatment plays a role in the management of lateral ankle ligament injury, the percentage of patients who eventually progress to surgery for ankle instability is not well defined in the literature[6,12].

Physical therapy (PT) is frequently prescribed as a treatment for lateral ankle ligament injury[4]. Formal PT is implemented for nonoperatively-treated ankle sprains, and as part of a post-operative rehabilitation program in patients who undergo lateral ankle ligament stabilization to address chronic lateral ankle instability. While studies have demonstrated that patients benefit from supervised PT exercises, evidence exists that self-directed home rehabilitation programs are just as effective as supervised PT[4,13,14]. There is limited literature addressing the financial burden of PT services. A Cochrane review comparing treatments for lateral ligament complex ankle injuries concluded that the current literature does not adequately compare the two treatment methods for ankle sprains—nonoperative and operative. It was mentioned that relevant cost outcomes would be beneficial for comparing conservative versus operative treatment interventions[15].

The primary aim of this study is to determine the incidence of patients diagnosed with lateral ankle sprain who ultimately progressed to operative treatment—either ligament repair or reconstruction. Secondary study aims included determining the implementation and cost of PT generated by the treatment of an ankle sprain diagnosis. Similar measures were obtained regarding lateral ankle bracing and Nonsteroidal anti-inflammatory drugs (NSAIDs).

Methods

Data was collected using the Pearl Diver Humana dataset. International Classification of Diseases, Ninth Revision (ICD-9), International Classification of Diseases, Tenth Revision (ICD-10), and Current Procedural Terminology (CPT) were used to create and sort groups of clinical diagnoses. Due to the use of a de-identified dataset, Institutional Review Board (IRB) approval was not required.

The diagnosis of lateral ankle sprain was identified through ICD coding. Nonoperative and operatively treated patients were sorted according to CPT code. ICD and CPT codes are summarized in Table 1. Inclusion criteria for operative treatment of lateral ankle sprain included either lateral ankle ligament repair or ligament graft reconstruction. Exclusion criteria for operative treatment included a history of multiple ligamentous ankle operations or other concomitant ankle operations; patients with multiple operative repairs or reconstructions were identified by repeated CPT codes. The percentage of ankle sprain patients who eventually underwent operative repair or reconstruction was calculated as the number of patients who underwent operative treatment divided by the total incidence of ankle sprain. Diagnostic costs associated with lateral ankle sprain were summed for the nonoperative and operative patient groups. Demographic data were collected for all patients to account for differences in gender, age, and geographical regions. ICD-10 codes for ankle sprains were also used to stratify results by injured ligament. Additionally, the incidence of multiple ankle sprains versus a single ankle sprain in the patient's history was assessed for each treatment group to evaluate its effect on treatment intervention.

Table 1. Patients with only one sprain code in the record versus multiple ICD sprain codes

Treatment	Single sprain	Multiple sprains
Nonoperative	207,896 (67.9%)	97,978 (32%)
Repair	215 (13.3%)	1,399 (87%)
Reconstruction	98 (9.3%)	956 (91%)

The prevalence of patients participating in PT before and after operative intervention was calculated, as well as PT participation after an isolated ankle sprain. The following criteria were used to classify incidence of patients participating in PT: Patients with CPT code(s) for PT in their medical record within one year of an ankle sprain diagnosis or lateral ankle ligament operation were included in the cohort classified as having received PT for their ankle injury, and patients who acquired CPT code(s) for PT within a year before their operation were classified as having received preoperative PT. The purpose of these time-period limitations was to exclude any PT received for diagnoses unrelated to their ankle injury, which is irrelevant to this study and could inaccurately increase the calculated percentage of patients receiving PT for ankle injury. A patient's duration of PT participation was calculated as the time between the initial episode of the ankle sprain and/or surgical intervention (defined as the "event") and the last PT session in the patient's medical record. The duration of time was compared between groups to determine the length of the PT course for patients receiving nonoperative versus operative treatment for their lateral ankle sprain.

All patients were further sorted as those who received NSAIDs, durable medical equipment (DME) bracing, or neither during their treatment course to stratify the use of different conservative treatment modalities within each group. Another identified metric was patients who received PT in addition to another conservative treatment modality. To address the potential for a patient simultaneously using multiple nonoperative treatment modalities, an additional therapeutic aid (aside from PT) was excluded when comparing these metrics. For example, the assumption was made that patients within the NSAID group did not concomitantly wear a therapeutic brace.

Statistics analysis

ANOVA was performed to compare the mean days participating in PT after the event and the mean days from the

event until a patient's last PT session across treatment groups. A post-hoc Tukey Honestly Significant Difference test was used to analyze the number of days between the event and the last PT that differed between groups. T-tests were used to compare the mean days in PT before and the mean days from first PT to the event for the repair and reconstruction groups. P-value was set at < 0.05 to be significant.

Results

A total of 309,670 patients with ICD codes for ankle sprains were identified in the Humana dataset. The demographic makeup of these patient populations, including gender, age, and geographical region, is outlined in Table 2. Use of a DME ankle brace, NSAID, and participation in PT are also reported in Table 2. Of the patients, 306,180 (99%; 306,180/309,670) did not have CPT codes for repair, reconstruction, or other operative ankle procedures and were subsequently classified as nonoperative patients. Additionally, 2,774 patients (1%; 2,774/309,670) had ICD codes for ankle sprain and subsequent CPT codes for ankle ligament repair or reconstruction. After excluding 106 patients (3.8%; 106/2,774) who underwent multiple ligament surgeries, 2,668 patients remained, having undergone one ankle reconstruction or repair. Of those who only underwent one ankle repair or reconstruction, 1,614 (60%; 1,614/2,668) patients remained in the ankle repair group, and 1,054 (40%; 1,054/2,668) remained in the reconstruction group. About 1% of patients with an ankle sprain ICD code eventually underwent operative ankle repair, and 0.3% eventually underwent operative ankle reconstruction. Overall, just under 1% (2,668/309,670) of the total ankle sprain population underwent ankle ligament repair or reconstruction operations. The operative group had a 60% higher prevalence of multiple sprains compared to the nonoperative group (Table 1). The ICD-10 codes for ankle ligament disruption or instability were used to determine relative estimates of the involvement of specific ankle ligaments in an ankle sprain (Table 3).

About 21% (63,276/305,879) of patients received PT in the nonoperative group, while a mean of 55% received PT after operative repair or reconstruction. Among the operative group, a lower percentage of patients underwent operative repair and had PT before their operation, after their operation, and in the group that had PT both before and after their operation. The mean number of sessions of PT per patient in the nonoperative group was 11 days, and the median time between the initial sprain diagnosis and the last day of PT was 139 days. In the operative repair group, the mean number of PT sessions before the operation was 7 days per patient, and after the procedure, it was 11 days per patient. The

Table 3. Code ligament percentages

Code	Total number of codes	% of total ICD-10 codes
Unspecified ankle ligament	36,684	69%
Calcaneofibular ligament	4,152	8%
Sprained ankle ligament, other	8,622	16%
Other ankle instability	3,875	7%

Table 2. Overview of demographics

Nonoperative				Operative			
Number of patients							
306,180 (98.9%)				2,668 (0.8%)			
Gender							
Male		Female		Male		Female	
109,730 (35.8%)		196,458 (64.2%)		1,066 (39.9%)		1,591 (59.6%)	
Age							
<20	20-40	40-60	>60	<20	20-40	40-60	>60
54,365 (17.7%)	56,182 (18.3%)	74,005 (24.2%)	131,127 (42.8%)	230 (0.8%)	605 (22.6%)	939 (35.2%)	894 (33.5%)
Region							
MW	NE	South	West	MW	NE	South	West
77,149 (25.1%)	4,828 (1.57%)	197,956 (64.6%)	26,319 (8.5%)	733 (27.5%)	38 (1.4%)	1,539 (57.7%)	361 (13.5%)
Use of physical therapy after the event							
63,276 (20.6%)				1,466 (54.9%)			
Use of DME Braces							
17,278 (5.6%)				526 (19.7%)			
Use of NSAIDs							
63,428 (20.7%)				581 (21.8%)			

MW: Midwest; NE: Northeast. Note: The discrepancy in the total percentage of patients is due to some patients being excluded due to undergoing other ankle surgeries.

median time between procedure and the last day of PT was 53 days. In the reconstruction group, the mean number of PT sessions was 8 before the operation and 11 after. The median time between reconstruction operation and the last day of PT was 51 days (Table 4).

Statistical analysis of differences in physical therapy

The mean number of days from the event to the last PT was significantly different ($F = 49.8644$, $p < 0.0001$); nonoperative patients participated in 59 more days of PT than those in the repair group (95% CI: 41.93, 75.78) and about 51 more days than those in the reconstruction group (95% CI: 30.63, 71.34). No significant difference was identified between ligament repair and reconstruction. No significant difference was found between any groups ($F = 0.1040$, $p = 0.9013$) in days of PT after the injury event.

There was no significant difference in mean days in PT before repair or reconstruction ($t = 0.6896$, $p = 0.4066$). The mean number of days from the first PT to the event was also not significantly different between the two groups ($t = 0.0722$, $p = 0.7882$).

A total of 58,065 (19%; 58,065/305,874) nonoperative patients used NSAIDs during recovery compared to 235 (15%; 235/1,614) repair patients and 193 (18%; 193/1,054) reconstruction patients. Similarly, 12,120 (4%/305,874) nonoperative patients used DME Braces during recovery, along with 233 (14%; 233/1,614) repair patients and 145 (14%; 145/1,054) reconstruction patients. The median number of days until last PT for patients who received NSAIDs after was 164 for nonoperative and 56 and 49 for repair and reconstruction, respectively. The median days until last PT for patients who received braces was 71 for nonoperative and 50 for both operative groups. The mean PT days per patient for nonoperative patients using NSAIDS was 13.6, and for repair and reconstruction was 15 days each. The mean PT days for nonoperative patients using braces were 13, 14, and 12 days for repair and reconstruction, respectively (Table 5).

The mean diagnostic cost of an ankle sprain ICD code without PT or further procedures was $400.51. The mean cost of PT per patient for nonoperative patients was $1,488.71, while the mean cost of PT for a repair patient before operation was $632.08 and after operation was $1,029.25. These results are summarized in Table 6.

Table 4. Overview of physical therapy use

	Patients who got PT Before	Patients who got PT After	Mean days in PT before	Mean days in PT after	Median days from first PT to event	Median days from event to last PT
Nonoperative	-	63,276 (20.6%)	-	11.01	-	139
Repair	365 (22.6%)	868 (53.7%)	7.93	11.03	351	53
Reconstruction	304 (28.8%)	598 (56.7%)	8.46	11.21	391	51

Table 5. NSAID and bracing use between treatment groups

	Treatment group	Patients	Patients who also received PT	Median days until last PT	Mean PT days/patient
NSAIDS	Non-Op	58,065 (18.9%)	16,669	164	13.6
	Repair	235 (14.5%)	140	56	15.2
	Reconstruction	193 (18.3%)	124	49	15.9
DME Braces	Nonoperative	12,120 (3.9%)	4,977	71	13.4
	Repair	233 (14.4%)	158	50	13.7
	Reconstruction	145 (13.7%)	97	50	12.2
Neither	Nonoperative	230,713 (75.4%)	40,500	137	10.2
	Repair	789 (48.9%)	524	52	11.4
	Reconstruction	642 (60.9%)	338	54	11.6

Table 6. Diagnostic and physical therapy costs

Treatment	Diagnostic cost ($)	Physical therapy Before event: Cost per patient	Physical therapy After event: Cost per patient	Total cost per patient
Nonoperative	$400.51	-	$1,488.71	$1,889.22 with PT, $400.51 without PT
Repair	$2,149.55	$632.08	$1,029.25	$3,810.88
Reconstruction	$2,162.85	$637.05	$1,098.51	$3,898.41

Discussion

Only about 1% of patients with an ankle sprain diagnosis proceed to operative treatment. Our results provide insight into previously published literature indicating that nonoperative ankle sprain treatment could reliably resolve a patient's symptoms, depending on the severity of the clinical case[3]. With higher severity of ankle sprains, however, there are still a considerable number of patients who ultimately undergo operative intervention to stabilize their lateral ankle ligament complex and will incur the higher costs associated with their care. Additionally, despite the lower diagnostic costs of nonoperative care, the high prevalence of ankle sprains and the higher prevalence of nonoperative care versus operative care mean that there is still an appreciable economic cost of lateral ankle sprains nationwide. Our data also show that a small percentage of patients undergo multiple-ligament procedures (3% repeat repair, 5% repeat reconstruction), which could give insight into the success rate of operative repair and/or reflect the complexity associated with operative reconstruction. No conclusion can be drawn upon this, but it could be a focus of future study. Both operative treatment groups had a higher percentage of patients who sustained multiple nonoperative ankle sprains than the nonoperative treatment group (87% repair, 91% reconstruction versus 32% nonoperative). Considering that candidates for operative repair of lateral ankle ligaments generally have first failed a nonoperative treatment course[16], it is unclear whether this is related to the data collected, revealing a higher percentage of operative patients have a history of multiple sprains.

Demographically, more patients over age 40 received operative intervention, but there was little difference in the type of operative intervention between the 40-60 age range and the 60+ age group. Nonoperative management had its largest percentage of patients in the 60+ age group. Lee et al.[17] reviewed the role of age in foot and ankle operations and concluded that multiple other factors, such as medical history, physical condition, and ambulatory status, must be considered before determining whether a patient's age is a contraindication to operative treatment of the ankle. All three treatment groups had a higher percentage of female patients than male, which parallels the findings of a systematic review reporting that ankle sprains are generally more common in females[18]. Doherty et al.[18] reported that the risk of a female athlete to sprain the ankle versus a male per exposure was 13.6 versus 6.94 per 1,000 exposures. In this study, 64% of total patients with ankle sprains (operative and nonoperative) were female, while only 36% were male. The difference in ankle sprains warrants further investigation.

While some patients participate in formal PT for ankle sprain rehabilitation, most nonoperative patients recover without supervised therapy. In the operative repair and reconstruction patients, higher percentages (53% and 56%, respectively) receive PT than nonoperative patients (21%). In a systematic review by Feger et al.[19], supervised rehabilitation for ankle sprains improved by a more significant margin of subjective patient outcomes compared to self-directed rehabilitation. Feger et al.[19] also found that the cost-effectiveness of home versus supervised PT was an area of research opportunity. Rao et al.[20] reported that manual therapy resulted in more significant improvements in ankle pain and function than home exercise programs. Our study found that PT increased the cost of treatment for an ankle sprain nonoperatively by a mean of $1,488.71 and for operative patients by $1,063.88. Although PT increases the overall patient cost, if patients experience significantly more favorable outcomes, this cost may be justified. Nonoperative patients attended PT for a considerably extended period, although they did not receive significantly more PT sessions.

A higher percentage of operative patients used DME braces than nonoperative patients (14% repair, 14% reconstruction versus 4% nonoperative patients). Functional support, including braces, was found to be favorable for the treatment of both acute and chronic ankle sprains to help decrease episodes of instability[21]. NSAID use was similar between both operative and nonoperative groups (14.5%, 18.3% versus 18.9%). Conservative treatment of lateral ankle sprain included NSAID use, bracing, and PT[22].

Our study estimated the diagnostic costs of an ankle sprain to be $400.51. In a study conducted in the Netherlands, the average cost per ankle sprain—excluding medical equipment or further sequelae—was $403.52, a close match to the $420.55 cost per ICD code reported in this study[23]. Shah et al.[24] aimed to assess the cost of an ankle sprain by sampling patients from emergency room visits. They found the mean cost of an ankle sprain to be $1,029. Another study examined the total societal cost of joint sprains ($9,196) and ankle injuries ($11,925) but did not break down the costs by diagnosis[7]. Although the latter two studies show higher costs than this study, they failed to examine ankle sprains specifically and only the healthcare costs associated with them. In this study, the cost of PT substantially increased the overall cost for a nonoperative patient, totaling 79% of the total cost. For operative patients, PT accounted for approximately 44% of the patient's total cost, indicating that although it was still a substantial cost, the operation accounted for a higher proportion. The cost-effectiveness of ankle sprain treatment beyond the initial diagnosis is an area that requires further research[6].

Limitations

The most significant limitation of this study is that using an insurance database does not capture the entire scope of a patient's medical record. Many individuals likely do not seek care for a minor ankle sprain, or their charts may not accurately reflect the care they receive. There could also be variation in how different providers use CPT codes. Additionally, an insurance database captures only the costs billed to the patient's insurance, not the patient's out-of-pocket costs.

The ICD codes used are not specific to different grades of ankle sprains, nor do they accurately describe the ligaments involved. Therefore, it is challenging to correlate whether one

group had a significantly greater degree of high-grade sprains than the other. However, we can infer that the operative group would have more high-grade sprains since higher-grade injuries have a higher likelihood to need additional treatment and operation[25]. Therefore, the nonoperative group may contain more patients who require less PT (or no PT) because they have only a minor grade I sprain. Finally, this study could not determine a patient's health status or whether they were an athlete. Both could be additional predictors of a patient's recovery from an ankle sprain. A major limitation of this study is that the economic impact could not be correlated with patient outcomes or recovery. Thus, further studies are needed to better account for these variables in relation to patient outcomes after ankle sprains.

Conclusions

This study demonstrates that most patients with lateral ankle ligament sprains do not progress to operative treatment. Females are more likely to sprain their ankle than males. Patients treated nonoperatively had fewer physical therapy visits per patient and generated lower costs than those treated operatively with a repair or reconstruction procedure. However, only 20% of nonoperative patients received PT, and only 26% had participated in PT before undergoing operative treatment. Future studies should focus on understanding the economic outcomes associated with the diagnosis and treatment of ankle sprains and their correlation with functional patient outcomes.

Authors' contributions: Each author contributed individually and significantly to the development of this article: CH *(https://orcid.org/0000-0001-5884-0027), RC *(https://orcid.org/0009-0007-1126-5193), WMM *(https://orcid.org/0000-0003-3991-7513) Were involved in conceiving and planning the activities that led to the paper and have interpreted the results achieved; BLM *(https://orcid.org/0000-0002-4518-4128), AT *(https://orcid.org/0000-0001-6803-6999) Were involved in planning the activities that led to the paper and reviewed successive versions of the reviewing process; MLV *(https://orcid.org/0000-0003-3362-1842) Were involved in conceiving and planning the activities that led to the paper, have interpreted the results achieved, and reviewed successive versions of the reviewing process; RR *(https://orcid.org/0000-0002-1176-9806) was involved in reviewing the successive versions and participated in the reviewing process; JPS *(https://orcid.org/0000-0002-0040-502X), SM *(https://orcid.org/0000-0001-5150-2658), BGV *(https://orcid.org/0000-0003-2647-2260) Were involved in planning the activities that led to the paper, reviewed successive versions of the reviewing process

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