DOI: https://doi.org/10.30795/jfootankle.2024.v18.1850

Original Article

Arthroscopy with lateral ankle ligament stabilization: benefit versus cost comparison

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Abstract

Objective: Compare the differences in cost, complications, new intra-articular diagnoses, and reoperations among patients with ankle instability submitted to lateral ankle ligament repair/reconstruction with or without arthroscopic procedures.

Methods: A retrospective analysis of 2,428 patients from the PearlDiver Humana dataset with ankle sprain or instability codes and compared outcomes between those submitted to lateral ankle ligament repair/reconstruction with or without arthroscopy.

Results: Patients without arthroscopy had higher complication rates (9.87% vs. 5.41%; χ^2[1, n = 1,236] = 5.83, p = 0.01), while the difference in reconstruction groups was insignificant (p = 0.09). Arthroscopy groups had higher rates of newly diagnosed intra-articular pathology: repair with arthroscopy (57.0%) vs. without (35.6%; χ^2[1, n = 1,236] = 44.47, p < 0.001); reconstruction with arthroscopy (63.0%) vs. without (39.8%; χ^2[1, n = 1,211] = 61.90, p < 0.001). Reoperation rates for intra-articular pathology were higher in the arthroscopy group (6.89% vs. 4.18%; χ^2[1, n = 2,433] = 8.09, p = 0.006), with significantly shorter time to reoperation (303 vs. 474 days, p = 0.045).

Conclusions: Arthroscopy does not increase complication rates and allows for earlier diagnosis and treatment of intra-articular pathology, potentially leading to earlier reoperation.

Level of evidence III; Retrospective Comparative Study.

Keywords: Lateral Ligament, Ankle; Arthroscopy; Ankle injuries; Cost-benefit analysis.

Introduction

Ankle sprains are a common injury, with an estimated incidence of 2.15 per 1,000 person-years presenting to an emergency department[1]. Although most cases can be treated non-operatively, a lateral ligament repair or reconstruction may be indicated in patients with chronic ankle instability following the initial injury[2]. Some patients suffer from persistent ankle pain despite the overall success of these procedures. The source of this pain is often thought to be unrecognized intra-articular pathology[3]. For this reason, ankle arthroscopy has been performed concomitantly with lateral ligament repair/reconstruction to identify and correct such pathology.

Intra-articular pathology has been found to accompany chronic ankle instability in 65%-90% of cases[4-6]. There is a clear indication for ankle arthroscopy when such pathology is identified by imaging or suspected clinically. Further, diagnostic arthroscopy immediately before lateral ligament repair/reconstruction has shown utility in identifying previously undiagnosed intra-articular pathology in at least two small case series[3,7]. For instance, in one study, magnetic resonance imaging detected only 72% of osteochondral

Study performed at the University of Kansas School of Medicine-Kansas City, Kansas City, KS, USA.

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How to cite this article: Heenan M, Parikh K, Tarakemeh A, Mersereau E, Long R, Morey T, et al Arthroscopy with lateral ankle ligament stabilization: benefit versus cost comparison. J Foot Ankle. 2024;18(3):389-93.

injuries subsequently identified by arthroscopic examination[7]. However, arthroscopy is an additional procedure that carries risks and could potentially increase the cost of lateral ligament repair/reconstruction. For example, there is a risk of injury to the superficial peroneal nerve in arthroscopy when creating the lateral portal[8,9].

To more clearly establish the utility of diagnostic ankle arthroscopy concomitant with lateral ligament repair/reconstruction, we sought to compile and evaluate a much larger case series than in published studies. The objective of this study is to compare the rates of diagnosis, reoperation, and complications for intra-articular pathology in lateral ligament surgeries with concomitant arthroscopy versus those without arthroscopy using a large health insurance database. In addition, analyze the costs associated with the procedures. We expect that the addition of diagnostic arthroscopy in lateral ligament surgeries will lead to earlier identification of intra-articular pathology and a lowered postoperative complication rate.

Methods

Data were collected from the PearlDiver Technologies Humana dataset, including records from over 25 million distinct patients at the time of the study from 2007 to the first quarter of 2017. A total of 2,428 patients with records of either ankle sprain or instability were included. These records indicated that patients were submitted to one of two procedures: lateral ankle ligament repair (native or *in situ* tissue) or lateral ankle ligament reconstruction (tendon autograft or allograft).

The study population was subdivided based on whether patients had at least one arthroscopic procedure (debridement or synovectomy) performed on the same day as the ligament repair or reconstruction. Patients in the "without arthroscopy" groups were confirmed to have no record of arthroscopic procedures on the day of the initial surgery, while patients in the "with arthroscopy" groups were submitted to concomitant ankle arthroscopy.

The two repair and two reconstruction groups were mutually exclusive, though 19 patients had records of repair and reconstruction procedures performed on separate occasions. These patients were included in the study, with each surgery considered separately. In total, 2,447 records were analyzed, excluding 408 patients with the current procedural terminology (CPT) codes for repair and reconstruction on the same day. Table 1 lists the International Classification of Diseases (ICD) 9/10 and CPT codes used for the inclusion and exclusion criteria.

The mean cost per patient, the incidence of complications, the rate of new intra-articular diagnoses, the proportion of patients requiring reoperations, and the mean time to reoperation were analyzed across all four groups. Costs, defined in the PearlDiver Humana dataset as reimbursements from Humana, were calculated by summing all patient records associated with ankle injury or instability ICD-9/10 codes within 90 days of the primary procedure. Complications were also evaluated within these 90 days and included hemorrhage, hematoma, wound disruption, peroneal nerve injury, painful hardware, infection, deep vein thrombosis, pulmonary embolism, and postoperative shock. Table 1 lists the ICD-9/10 codes used for these complications.

Reoperations were defined as any surgical procedures on the ankle occurring after the day of the primary procedure. These included ligament repair or reconstruction, arthroscopic debridement, synovectomy, arthrodesis, loose body removal, osteochondral defect excision, arthrotomy with joint exploration, incision and drainage, and syndesmosis repair. Intra-articular reoperations included all reoperations except liga-

Table 1. ICD-9/10 and CPT codes used for inclusion/exclusion criteria and complication assessment.

Inclusion/ Exclusion Criteria description	Code
Ankle Instability	ICD-10-D-M25371: ICD-10-D-M25373 ICD-9-D-71887
Ankle Sprain	ICD-10-D-S93401: ICD-10-D-S93409 ICD-10-D-S93411: ICD-10-D-S93419 ICD-10-D-S93491: ICD-10-D-S93499 ICD-9-D-84500: ICD-9-D-84509
Lateral Ankle Ligament Repair	CPT-27695
Lateral Ankle Ligament Reconstruction	CPT-27698
Ankle Arthroscopy	CPT-29897 CPT-29898 CPT-29895 CPT-29891 CPT-29894 CPT-29892
Complication Descriptions	**Code**
Postoperative shock	ICD-10-D-T8110X, ICD-10-D-T8111X, ICD-10-D-T8112X, ICD-10-D-T8119X
Hemorrhage	ICD-9-D-99800: ICD-9-D-99809, ICD-10-D-M96810, ICD-10-D-M96830, ICD-9-D-99811
Hematoma	ICD-10-D-M96840, ICD-9-D-99812
Disruption of wound	ICD-10-D-T8130X, ICD-10-D-T8131X, ICD-10-D-T8132X, ICD-9-D-99830: ICD-9-D-99833
Infection	ICD-10-D-T814XX, ICD-10-D-T8460X, ICD-10-D-T847XX, ICD-9-D-99851, ICD-9-D-99859, ICD-9-D-99667
Injury to peroneal nerve	ICD-10-D-S8410XA, ICD-9-D-9563
Painful hardware	ICD-10-D-T8484X, ICD-9-D-99678
Deep venous thrombosis	ICD-10-D-I82400: ICD-10-D-I82499 ICD-10-D-I824Y0: ICD-10-D-I824Y9 ICD-10-D-I82ZY0: ICD-10-D-I824Z9 ICD-9-D-45340: ICD-9-D-45342
Pulmonary embolism	ICD-10-D-I2699, ICD-9-D41511, ICD-9-D-41519

ment repair/reconstruction and incision and drainage. Newly diagnosed intra-articular pathology was defined as ankle defects not previously recorded in a patient's history but first appearing on the day of surgery or thereafter (up to a maximum of 10 years post-operation). Assessed intra-articular pathology included synovitis/tenosynovitis, osteophytes, loose bodies, osteochondral defects, syndesmosis injury, other osteochondropathies, articular cartilage disorders, and osteoarthrosis. Due to the compliance of the Health Insurance Portability and Accountability Act, data on groups with fewer than 11 patients could not be reported.

The statistical significance of cost differences was determined using t-tests through PearlDiver's interface with the R statistical package. Differences in proportions were compared using Chi-squared tests, and differences in the mean time to reoperation were analyzed with t-tests using Open-Source Epidemiologic Statistics for Public Health (OpenEpi) version 3.01. P-values less than 0.05 were considered statistically significant.

Results

As shown in Table 2, the study compared four main groups: repair with arthroscopy (n = 314), repair without arthroscopy (n = 922), reconstruction with arthroscopy (n = 473), and reconstruction without arthroscopy (n = 738). Additionally, combined arthroscopy (n = 787) and non-arthroscopy (n = 1,660) groups were analyzed. The most common new diagnoses were tenosynovitis, sprain of the tibiofibular ligament, osteophytes, and loose bodies. A significantly higher proportion of patients in the arthroscopy groups had newly diagnosed intra-articular pathology compared to their respective non-arthroscopy groups. Among those diagnosed with intra-articular pathology, patients submitted to arthroscopy were significantly more likely to receive a diagnosis on the day of surgery rather than later (Table 3).

The most common reoperations involved repeat ligament repair/reconstruction and debridement. There was no significant difference in the proportion of patients submitted to reoperation between the arthroscopy and non-arthroscopy groups: repair with arthroscopy (9.6%) vs. without (8.1%; χ^2 [1, n = 1,236] = 0.6, p = 0.44) and reconstruction with arthroscopy (6.8%) vs. without (8.8%; χ^2 [1, n = 1,211] = 1.6, p = 0.20). Similarly, there was no significant difference in time to reoperation. However, there was a significant difference in the proportion of patients submitted to intra-articular reoperations between the combined arthroscopy and non-arthroscopy groups, with the mean time to reoperation being significantly shorter in the combined arthroscopy group (Table 4).

The most common complications included painful hardware, infection, deep venous thrombosis, and wound disruption. Patients in the repair without arthroscopy group had a significantly higher rate of complications than those in the repair with arthroscopy group. A similar trend was observed in the reconstruction groups, though it did not reach statistical significance (p = 0.045). However, when comparing the combined arthroscopy and non-arthroscopy groups, the non-arthroscopy group had a significantly higher rate of complications (Table 5).

Table 2. Study cohorts.

Group	With arthroscopy (Frequency)	Without arthroscopy (Frequency)	Total (Frequency)
Lateral ankle ligament repair	314	922	1,236
Lateral ankle ligament reconstruction	473	738	1,211
Combined (repair + reconstruction)	787	1,660	2,447

Table 3. Patients with new intra-articular pathology.

Lateral ankle ligament repair	With arthroscopy n = 314	Without arthroscopy n = 922	χ2	p-value
Total	179 (57.0%)	328 (35.6%)	44.3	< 0.001
Received Day of Surgery	163 (91.1%)	235 (71.6%)	26.4	< 0.001
Lateral ankle ligament reconstruction	**With arthroscopy n = 473**	**Without arthroscopy n = 738**	**χ2**	**p-value**
Total	300 (63.4%)	294 (39.8%)	62.0	< 0.001
Received day of surgery	259 (86.3%)	198 (67.3%)	29.8	< 0.001

Table 4. Reoperations for combined lateral ankle ligament repair and reconstruction with and without arthroscopy.

Combined reoperation type	With arthroscopy n = 787	Without arthroscopy n = 1,660	χ2	p-value
Any reoperation	62 (7.9%)	138 (8.3%)	0.1	0.74
Intra-Articular reoperation	54 (6.9%)	69 (4.2%)	8.1	0.004
Mean time to intra-articular reoperation (days)	303	474	-	0.045

Table 5. Complication rates of lateral ankle ligament repair and reconstruction with and without arthroscopy.

Intervention	With arthroscopy	Without arthroscopy	χ2	p-value
Repair	5.4% (17/314)	9.9% (91/922)	5.9	0.015
Reconstruction	5.1% (24/473)	7.6% (56/738)	2.9	0.088
Combined (repair + reconstruction	5.2% (41/787)	8.9% (147/1660)	10.3	< 0.001

The mean cost per patient was significantly higher in the repair group with arthroscopy ($5,991.32) compared to the repair group without arthroscopy ($3,677.11; p < 0.001). This trend also was observed in the reconstruction groups, with the cost of reconstruction with arthroscopy at $5,744.83 and without arthroscopy at $4,601.13 (p < 0.001). The cost difference between repair with arthroscopy and reconstruction with arthroscopy was not significant (p = 0.59), but the difference between repair without arthroscopy and reconstruction without arthroscopy was statistically significant (p < 0.001).

Discussion

Our findings demonstrate that ankle arthroscopy at the time of lateral ligament repair/reconstruction was more expensive but allowed for an increase in the identification of intra-articular pathology at the time of the chosen procedure. Although overall reoperation rates were similar, patients submitted to ankle arthroscopy were more likely to have reoperations for intra-articular pathology. These reoperations occurred significantly sooner (171 days) than for patients not undergoing arthroscopy. Ankle arthroscopy detects potentially pain-generating pathology that could be addressed either during the chosen procedure or later, potentially explaining the increased and earlier reoperations to address these issues.

Several studies have demonstrated the high prevalence of intra-articular pathology accompanying lateral ligament injuries in patients suffering ankle sprain or instability[3,4,5,10,11]. One case series showed that arthroscopy with lateral ankle ligament surgery identified many intra-articular pathologies, which were undiagnosed before surgery, most notably synovitis, cartilage injuries, and loose bodies[3]. The authors speculated that these defects would not have been detected without arthroscopy. However, there was no control group for comparison and follow-up time was limited to the surgery.

Our study is the largest reported case series of patients with chronic ankle instability submitted to repair or reconstruction having concomitant ankle arthroscopy. We found that, without arthroscopy, potential intra-articular pathology is more likely to be diagnosed later during the follow-up, which extended to a maximum of ten years after the initial ligament repair/reconstruction surgery. Due to the restrictions on reporting data for groups of patients fewer than 11 in the PearlDiver dataset, the rates of specific diagnoses from the arthroscopy were not available for comparison. Since some intra-articular pathology has been shown to affect patient outcomes more than others[12], future studies of a larger population may show more detailed reporting of arthroscopic findings.

Our study also corroborated the finding of Yasui et al.[9] that there was no reduction in the overall reoperation rate when lateral ligament repair surgeries were performed with concomitant arthroscopic procedures. However, in the current study, there was an increase in intra-articular pathology reoperations and a decreased reoperation time. This was likely due to intra-articular pathology, which was recognized arthroscopically and addressed sooner than in patients who did not have arthroscopy. Komenda and Ferkel showed in a study of 55 patients undergoing ligament repair with arthroscopy that 93% of patients had intra-articular injuries requiring intervention[13]. With the high prevalence of intra-articular injuries associated with chronic lateral ankle instability, early identification and treatment likely lead to earlier resolution of symptoms and better patient outcomes.

A recent systematic review found the most common complications of lateral ligament repair/reconstruction surgeries included wound issues, superficial nerve damage with sensory disturbances, and superficial infections[8]. The review also noted a wide range of complication rates among the cohorts studied[8]. Our study found no significant difference in the overall complication rate between lateral ligament reconstruction with or without arthroscopy. However, our data demonstrated a significantly lower proportion of patients with complications in the combined arthroscopy group than in the combined without arthroscopy group. This finding likely indicates other factors affecting complication rates independent of the use of concomitant arthroscopy.

As expected, the mean cost of the procedure was higher in the arthroscopy groups than in the non-arthroscopy groups. The higher cost in the arthroscopy groups reflects the cost of utilizing the arthroscopy equipment, and the additional operating room and anesthesia time. However, the added cost of arthroscopy may be offset by the opportunity to address arthroscopic findings sooner, allowing patients to return quicker to a functional state.

Our study has several limitations. As a retrospective database review, many variables remain uncontrolled. Data on small groups of less than 11 patients could not be reported due to the compliance of the Health Insurance Portability and Accountability Act, which limits detailed analysis of individual complications, diagnosis, and reoperation rates. The timing and accuracy of diagnoses and procedures rely on the providers' reporting practices, and some diagnoses may be clinically insignificant but still recorded. Additionally, minor complications captured in other studies may not be reflected here, as they may lack formal diagnostic codes reported to private insurers. The cost analysis was limited to reimbursements from private insurers, which may not accurately reflect patient costs or physician reimbursements.

Furthermore, the authors did not include outcome data in the study as they were not documented in the PearlDiver Humana Dataset, making it unclear whether the diagnosis and treatment of intra-articular pathology improved patient function. Determining the overall difference between the arthroscopy and non-arthroscopy groups is challenging without these outcome metrics. However, the need for reoperation could suggest that patients were not progressing as expected postoperatively, and early identification of intra-articular pathology in the arthroscopy group may have facilitated earlier reoperation and recovery.

Conclusions

Concomitant arthroscopy with lateral ankle ligament surgery is more expensive but does not appear to increase the overall complication rate. This approach enables surgeons to diagnose and treat more intra-articular pathologies, allowing defects to be addressed, on average, five months earlier with reoperation, which may justify the additional cost. Our findings support the hypothesis that concomitant arthroscopy leads to earlier identification of intra-articular pathology, potentially improving patient outcomes. Ankle arthroscopy seems to be a safe adjunct to lateral ankle ligament surgery for ankle sprain or instability, providing the opportunity to identify and treat intra-articular pathology that could potentially impact patient outcomes.

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