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Original Research

Complications Associated with Foot and Ankle Arthroscopy

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ABSTRACT

Despite a late start within the realm of arthroscopy, foot and ankle arthroscopy proves to be an important diagnostic and treatment tool for the foot and ankle specialist. As indication for arthroscopy increases, complications associated with foot and ankle arthroscopy must be revisited. We reviewed 405 foot and ankle arthroscopic procedures performed on 390 patients in 4 different facilities over a 3-year period extending from January 2005 to August 2008. Two-hundred-sixty foot and ankle arthroscopic procedures on 251 patients met our inclusion criteria. A total of 246 ankle and 14 posterior subtalar arthroscopic procedures were performed with a mean follow-up of 10.7 ± 3.5 months. Patient demographics, preoperative findings, intraoperative technique, and postoperative course were reviewed. We failed to identify statistically significant predictive factors for complications. Arthroscopy performed in combination with adjunctive procedures showed a trend toward higher complication rate, although statistical significance was not noted. Overall, 20 cases (7.69%) experienced arthroscopy-related complications, and this finding was comparable with previously published results. The most common complication was cutaneous nerve injury, which involved 9 cases (3.46%), and localized superficial infection, which involved 8 cases (3.08%). Injury to the superficial peroneal nerve accounted for 5 of the cutaneous nerve injuries. There were no cases of arthroscopy-related vascular injury. All cases of superficial postoperative infection resolved with antibiotic therapy, and none of the cases required return to the operating room. These results were also similar to published data.

In 2001, Ferkel and colleagues presented a review of complications associated with foot and ankle arthroscopy, during which they reported their experience with 612 ankle arthroscopic procedures (1). They cited a 9% overall complication rate, with the most common being neurological injury, which accounted for essentially half of the complications. This compared favorably with earlier studies with complication rates ranging from 14% to 17% (2–4). Other reports suggested lower complication rates with arthroscopy (0.56%, 0.6%, and 1.7%) (5,6). These lower complication rates have been called into question by some authors who feel they underestimate the true complication rate (1). It has also been suggested that neurovascular complications occur more often in association with the ankle arthroscopy in comparison with arthroscopic surgery at other joints (7). Variations in the course of the cutaneous nerves about the ankle may predispose to nerve entrapment or sectioning associated with arthroscopic surgery. One cadaver study showed that approximately 33% of specimens displayed an accessory deep peroneal nerve, specifically an additional branch from the sensory division of superficial peroneal nerve, which courses through the anterior compartment of the leg and passes deep to the extensor retinaculum to supply the anterior aspect of the ankle and the dorsum of foot (8). Vascular injuries are also possible in association with ankle arthroscopy. The vulnerability of the anterior tibial artery and its branches has also been described, and ankle flexion has been suggested as a means of decreasing the potential for injury to the malleolar arteries (9). Furthermore, in 22 (6.2%) of 358 cases, the anterior tibial artery and its branches were noted to be located near the anterolateral ankle portal, which predisposes this particular vessel to injury during arthroscopic surgery (10). Finally, one report noted that noninvasive distraction has been associated with an overall 6.8% prevalence of complications, although subjective complaints of postarthroscopy nerve symptomatology were more prevalent in worker's compensation cases (11).

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The goal of this retrospective cohort study was 2-fold. First, in light of the current increasing array of indications for foot and ankle arthroscopy, the authors aimed to determine the incidence of overall complications after foot and ankle arthroscopy. Second, the authors aimed to explain the association of complications with patient demographic variables, preoperative findings, intraoperative technique, and postoperative course to identify significant risk factors that may predict the development of a complication. To the best of our knowledge, there are no results previously published in the peer-reviewed literature that describe complications after foot and ankle arthroscopy collectively.

Patients and Methods

We conducted a multicenter review of 405 foot and ankle procedures that were performed in 390 patients at 4 different facilities over a 3-year period extending from January 2005 to August 2008. Of these procedures, 260 foot and ankle arthroscopic cases in 251 patients met our inclusion criteria. Four staff surgeons (authors GAH, LAF, SMR, and ML) performed all the procedures and coauthored this report. Arthroscopic foot and ankle procedures were performed as an isolated intervention, or in combination with other surgical procedures, including use of the arthroscope to aid reduction of acute intra-articular fractures and to inspect the joint cavity after acute injury. Furthermore, the follow-up period had to be $\geq$ 6 months' duration. Patient records were retrieved from our medical records system. The following independent variables were abstracted from their records: age in years; gender; side of operation, categorized as right, left; joint involvement, categorized as ankle or subtalar; comorbidity, categorized as diabetes mellitus, peripheral neuropathy, peripheral vascular disease, tobacco use (active or not), and chronic pain; duration of symptoms in months; prior ipsilateral procedures; etiology, categorized as ankle sprain, ankle fracture, calcaneal fracture, tibial fracture, talus fracture, status after hindfoot fusion, ankle sepsis, pigmented villonodular synovitis, gout, no trauma, and not reported; operative technique, categorized as distraction, microfracture, radiofrequency ablation, adjunct procedure(s), and arthroscopic fusion; complications, categorized as nerve injury, infection, deep vein thrombophlebitis, and continued pain; and the duration of follow-up in months. Postoperative infections were included as complications of the arthroscopy only if they were localized to the arthroscopic portals or the involved joint. Neurological complications were included as complications only if they were directly attributed to the arthroscopic surgery, and if they were identified at any time after the operation.

Surgical Intervention

In all cases, standard arthroscopic technique was performed with the patient supine and a hip bump on the ipsilateral side. Thigh tourniquets and noninvasive ankle joint distraction were used according to the surgeon's preference and the anticipated degree of intra-articular disease. Small (2.7-mm) and large (4-0 mm) joint arthroscopes, with 30° optics, were used in every case, and standard anteromedial and anterolateral portals were developed with care to preserve all neurovascular structures. A posterolateral portal was developed to visualize posterior structures only if indicated based on operative findings. Once the joint cavity was entered, a systematic inspection of intra-articular structures was performed. Appropriate shavers, debriders, and radiofrequency ablators were used as indicated. When osteochondral defects were present, a small bone awl or bone pick was used to microfracture the lesion until bleeding subchondral bone was visualized. Photographs and/or video recordings were obtained and maintained as part of every patient record. After completion of the arthroscopic intervention, the portals were closed with suture either at the subcutaneous layer or directly over the skin.

For all subtalar arthroscopic procedures, a standard lateral approach was taken to visualize the posterior articulation. Anterolateral and middle portals were developed with respect to adjacent neurovascular structures. The small (2.7-mm, 30° optics) arthroscope was inserted to provide maximal visualization. Appropriate shavers or debriders were inserted to decompress areas of impingement if present. When performed during acute intra-articular fracture management of the calcaneus, arthroscopic visualization confirmed anatomic reduction. Portal closure was carried out in the same fashion as that described above for the ankle portals.

For cases that entailed additional concomitant foot or ankle procedures, arthroscopy was performed first to capitalize on the undisturbed intra-articular environment. Exceptions to this rule included acute intra-articular injuries when arthroscopy was used to confirm reduction or to address acute osteochondral injury.

All patients were immobilized postoperatively in a posterior splint until at least the first postoperative appointment. Depending on whether concomitant procedures were undertaken, as well as the intraoperative findings, patients were further immobilized up to a total of 6 weeks with a fixed brace or a short leg fiberglass cast. Weight-bearing restrictions also varied from immediate protected weight-bearing to non–weight-bearing for 6 weeks according to the requirements of the concomitant procedures and intraoperative findings. The postoperative course for all patients entailed a first postoperative appointment at 1 to 2 weeks after the operation, during which skin sutures were removed if the incisions were healed. Thereafter, follow-up appointments were conducted and continued until satisfactory resolution of symptomatology and surgical healing was complete.

Statistical Methods

Patient characteristics and procedures were summarized using frequency count and percentage for categorical variables, mean $\pm$ SD for continuous variables with a normal distribution, and median with interquartile (25th to 75th) range for continuous variables with a distribution that was not normal. These summary measures were calculated for the group as a whole and then separately for those who did and did not have complications. Comparisons between the 2 groups were done using Fisher's exact test for categorical variables, Student's 2-sample t test for continuous variables with a normal distribution, and the Wilcoxon rank-sum test for continuous variables with a distribution that was not normal. Statistical significance was defined at the 5% ($p \leq .05$) level.

Results

Over the 3-year observation period, 251 patients met our inclusion criteria and were retrospectively analyzed in regard to 260 arthroscopic interventions, 246 (94.62%) of which involved the ankle, and 14 (5.38%) of which involved the posterior subtalar joint. In all subacute and chronic cases, arthroscopic intervention was undertaken only after the attending surgeon had decided that nonsurgical treatment efforts had failed to provide satisfactory relief. Table 1 depicts the statistical description of the cohort. The overall median (25th and 75th percentile) age was 41.5 years (30 and 53 years). Gender and laterality of the operative extremity were roughly equal. The median (25th and 75th percentile) duration from injury or initiation of symptom to arthroscopy was 12 months (5 and 12 months), and 68 (26.15%) patients had undergone a prior operation on the symptomatic extremity. The most common etiology was ankle sprain (146/56.15%) followed by ankle fracture (58/22.31%). Distraction was used in 27 (10.38%) cases, microfracture technique in 67 (25.77%) cases, and radiofrequency ablation in 43 (16.54%) cases. Adjunctive procedures in addition to arthroscopy were performed in 90 (34.62%) cases. The mean follow-up period was 10.7 months with a standard deviation $\pm$ 3.5 months.

Twenty (8%) complications were documented within the postoperative course. The most common complication was neurologic injury accounting for 45% of the 20 complications, followed by infection at 40% of the complications. There were also 2 cases of continued pain and 1 case of symptomatic, nonfatal deep vein thrombophlebitis. Of the neurologic complications, the superficial peroneal nerve was the most susceptible at 25% of all complications, followed by the deep peroneal nerve at 10%, and then the sural and saphenous nerve at 5% each.

For those patients who experienced postoperative complications, the median (25th and 75th percentile) age was 48.8 years (37.8 and 58 years). Gender and laterality of the operative extremity were roughly equal. The median (25th and 75th percentile) duration from initiation of symptom to arthroscopy was 11.6 months (7 and 12 months). Five (25%) patients had a prior procedure on the operative leg. The most common etiology was ankle sprain (11/55%) followed by ankle fracture (6/30%). Distraction was used in 4 (20%) cases, microfracture technique in 4 (20%) cases, and radiofrequency ablation in 4 (20%) cases. In addition, 8 (40%) cases with complications had a second procedure done on the same extremity during the same case. There were no statistically significant differences between those with and those without complications (Table 2).

Discussion

There have been several landmark studies within the past decade detailing complications of ankle arthroscopy (1–7). Along with an

Table 1
Statistical description of the cohort (N = 260 procedures in 251 patients)

Variable			Count (%), Mean ± SD, or Median (25th, 75th percentile range)
Age (y)			41.5 (30, 53)
Gender (n = 251 patients)	Male		125 (49.8)
	Female		126 (50.2)
	Right		134 (51.53)
	Left		126 (48,47)
Joint (n = 260 cases)	Ankle		246 (94.62)
	Subtalar		14 (5.38)
Comorbidity (n = 251 patients)	Diabetes mellitus		17 (6.77)
	Peripheral neuropathy		3 (1.19)
	Peripheral vascular disease		1 (0.4)
	Active tobacco use		51 (20.32)
	Chronic pain		6 (2.39)
Duration of symptoms (mo)			12 (5,12)
Prior procedures			68 (26.15)
Etiology (n = 260 cases)	Ankle sprain		146 (56.15)
	Ankle fracture		58 (22.31)
	Calcaneal fracture		6 (2.31)
	Tibia fracture		2 (0.77)
	Talus fracture		1 (0.38)
	Status after hindfoot fusion		2 (0.77)
	Ankle sepsis		1 (0.38)
	PVNS		1 (0.38)
	Gout		1 (0.38)
	None (not reported)		20 (7.70)
	Not reported		19 (7.31)
Operative technique (n = 260 cases)	Distraction		27 (10.38)
	Microfracture		67 (25.77)
	Radiofrequency ablation		43 (16.54)
	Adjunct procedure(s)		90 (34.62)
	Arthroscopic fusion		15 (5.77)
Complications (n = 260 cases)	Nerve injury	Superficial peroneal	5 (1.92)
		Deep peroneal	2 (0.77)
		Sural	1 (0.38)
		Saphenous	1 (0.38)
	Infection		8 (3.08)
	Deep vein thrombophlebitis		1 (0.38)
	Continued pain		2 (0.77)
Duration of follow–up (mo)			10.7 ± 3.5

Abbreviation: PVNS, pigmented villonodular synovitis.

Table 2
Prevalences of risk factors by outcome (N = 260 procedures in 251 patients)

Variable	No Complication (n = 240)	Complication (n = 20)
Age (y): median (25th, 75th percentile range)	40.9 (30, 52)	48.8 (37.7, 58)
Male sex (count [%])	116 (48.33)	9 (45)
Right side (count [%])	122 (50.83)	12 (60)
Ankle joint (count [%])	227 (94.58)	19 (95)
Subtalar joint (count [%])	13 (5.42)	1 (5)
Diabetes mellitus (count [%])	16 (6.67)	1 (5)
Peripheral neuropathy (count [%])	3 (1.25)	0 (0)
Peripheral vascular disease (count [%])	1 (0.42)	0 (0)
Tobacco use (count [%])	48 (20)	3 (15)
Chronic pain (count [%])	5 (2.09)	1 (5)
Duration of symptoms (mo): median (25th, 75th percentile range)	12 (5, 12)	12 (7, 12)
Prior procedure (count [%])	63 (26.25)	5 (25)
Ankle sprain (count [%])	135 (56.25)	11 (55)
Ankle fracture (count [%])	52 (21.67)	6 (30)
Calcaneal fracture (count [%])	6 (2.5)	0 (0)
Tibial fracture (count [%])	2 (0.83)	0 (0)
Talus fracture (count [%])	1 (0.42)	0 (0)
Status after hindfoot fusion (count [%])	2 (0.83)	0 (0)
Ankle sepsis (count [%])	1 (0.42)	0 (0)
PVNS (count [%])	1 (0.42)	0 (0)
Gout (count [%])	1 (0.42)	0 (0)
No history of trauma (count [%])	18 (7.5)	2 (10)
Not reported (count [%])	18 (7.5)	1 (5)
Distraction (count [%])	23 (9.58)	4 (20)
Microfracture (count [%])	63 (26.25)	4 (20)
Radiofrequency ablation (count [%])	39 (16.25)	4 (20)
Adjunct procedure(s) (count [%])	82 (34.17)	8 (40)
Arthroscopy only (count [%])	158 (65.83)	12 (60)
Arthroscopic fusion (count [%])	13 (5.42)	2 (10)
Duration of follow–up (mo): mean ± SD	10.8 ± 3.5	10.1 ± 3.0

Abbreviation: PVNS, pigmented villonodular synovitis.
No comparison between those with and without complications was statistically significant ($p > .05$).

increase in the indications for, and the complexity of arthroscopic procedures, the opportunity for arthroscopic complications presumably should increase as well. Our overall incidence of complications of 7.69%, as well as our incidence of neurological complications of 3.46%, proved comparable with results previously reported in peer-reviewed literature (1,12). Of the nerve injury complications, injury involving the superficial peroneal nerve was most prevalent (1.92%), followed by injury to the deep peroneal (.77%), and then the sural and saphenous nerves (.38% each). The second most common complication encountered in our cohort of patients was superficial infection localized to the arthroscopic portals, and the incidence of this was 3.08%, and in each case the infection resolved after a short course of oral antibiotics without the need for additional surgical treatment or hospitalization. Furthermore, we observed no cases of deep infection and no cases of arthroscopy-related vascular injury.

Numerous anterior, posterior, and transmalleolar portals for arthroscopic access to the ankle have been described in the literature (1–6,12). Because of the abundance of surface landmarks, high predictability of portal placement, and location of most intra-articular pathology, we believe that almost all ankle arthroscopy procedures can be performed with the use of an anterior approach. In the series of patients that we reviewed, all ankles were routinely inspected with standard anteromedial and anterolateral portals. If posterior pathology was identified, and if improved visualization was required, a posterolateral portal was made with an inside-out technique to ensure the safety of adjacent neurovascular structures. Because of the presence of minimal skin coverage and subcutaneous tissue at the anterior ankle, wound complications, in particular tendon and nerve and vascular injuries, can only be minimized with a thorough knowledge of the extra-articular anatomy about the ankle.

Before portal placement, anatomical landmarks such as the anterior joint line, dorsalis pedis artery, and great saphenous vein need to be palpated and marked. In addition, every attempt to locate neural structures should be made. In particular, inverting the foot and ankle and directly inspecting and palpating the skin surface can accentuate visualization of the superficial peroneal nerve. Stephens and Kelly proposed a technique by which flexion of the fourth toe allowed easier visualization of the nerve (13). The anteromedial portal is typically developed first because of the predictable presence of the key anatomic structures. The notch of Harty, which can be found at the junction of the anterior tibial edge and the medial malleolus, provides additional passage for instruments from the anteromedial side. When establishing this portal, which is just medial to the tibialis anterior tendon at the anterior joint line, the potential for injury to the saphenous nerve and great saphenous vein should be appreciated. Feiwell and Frey described mean distances of 7.4 mm and 9 mm, for the distance between the notch of Harty and the saphenous nerve and great saphenous vein, respectively (14). Ferkel and colleagues reported a less than 1% risk of injury to the saphenous nerve in association with ankle arthroscopy (12). In our series, only 1 (0.38%) case of saphenous nerve injury was documented out of 260 procedures.

The anterolateral portal can be developed just lateral to the peroneus tertius tendon at the anterior joint line. In addition to anatomic landmarks, establishment of this portal can be aided with

a transillumination technique in an inside-out manner, and the main structures at risk are the superficial peroneal nerve and its branches. Anatomic distances and patterns of this particular nerve in relationship to the anterolateral portal have been reported (14), and it is known that the pattern and distribution of the superficial peroneal nerve varies greatly (15). As such, it may be impossible to predict the exact anatomic location of at-risk neural structures while developing the anterolateral portal. Ferkel and coworkers reported a 2.5% risk of superficial peroneal nerve injury in association with ankle arthroscopy (12). In our series, 5 (1.92%) cases of superficial peroneal nerve injury were documented.

Our analyses failed to identify any predictive factors for complications associated with foot and ankle arthroscopy. It is logical that as arthroscopic procedures become more complicated, complications associated with the procedures should also increase. We examined the prevalence of complications in association with arthroscopic procedures during which other adjunct procedures were performed. Of the 90 foot and ankle arthroscopic procedures that were performed with additional procedures, 8 complications were isolated for a rate of 8.89%. Of the remaining 170 arthroscopic procedures performed in isolation, there were 12 complications with a rate of 7.06%. It is our general opinion that there is a higher rate of complications as the prevalence of arthroscopic procedures increases and the types of intervention become more technically involved. However, we were unable to identify any statistical significance ($p < .05$) between risk factors and complications after arthroscopic foot and ankle surgery. This inability may be due to a type 2 statistical error, where we failed to identify a statistically significant relationship because our sample was too small.

As with many retrospective cohort studies, a number of methodological shortcomings could have influenced our ability to make valid conclusions. We have already discussed the potential influence that a small sample size could have had on our ability to identify statistically significant differences between risk factor variables and the development of a complication related to ankle or subtalar arthroscopy. In addition to this, we depended on information documented in the medical records, much of which was produced by the investigators who were also the surgeons of record, and this could have imparted bias even when the investigators tried to be objective. Furthermore, we did not test the sensitivity of our results to the potential influence of unmeasured variables, although we did not feel that this was required because we were not able to identify any statistically significant associations. Finally, some readers may think that our minimum follow-up duration of 6 months could have been too short to identify some potential complications; however, we felt that it was long enough to enable us to identify arthroscopically induced wound problems as well as inadequate relief of pain.

In conclusion, foot and ankle arthroscopy is still relatively new compared with general orthopaedic arthroscopic procedures. However, much knowledge has been gained regarding instrumentation and technique since the first ankle arthroscopic procedures were performed, and the indications for arthroscopic intervention in the ankle, and even the subtalar joint, are expanding. As more elaborate intra-articular procedures are undertaken, such as arthroscopic fusion and acute fracture reduction, complications from these procedures need to be considered. In our series, we failed to identify any predictive factors for complications associated with foot and ankle arthroscopy, despite our widespread use of the arthroscope. Our overall complication rate of approximately 8% appears to be comparable with previously reported results, although we appreciate the limitations of making comparisons with historical controls. Based on our experience with the patients described in this report, we believe that arthroscopic ankle and hindfoot surgery is safe and effective, and that the diagnostic and therapeutic indications for this type of surgery will continue to expand. We also feel that the results of this retrospective cohort study can be used in the development of future randomized controlled trials and prospective cohort studies that focus on arthroscopic foot and ankle surgery.

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