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Ankle Arthroscopy: A Complimentary Adjunct in the Diagnosis and Management of Ankle Fractures

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Abstract

Ankle fractures are one of the most common injuries treated by orthopaedic surgeons. A minority of patients with ankle fractures go on to develop persistent pain following anatomical reduction. These sequelae may arise as a result of untreated ligamentous or chondral injuries. This study aims to correlate acute arthroscopic ankle findings with the *Lauge-Hansen* fracture pattern classification. We further aim to compare subjective functional outcomes at least one year following surgery between patients who have received Open Reduction and Internal Fixation (ORIF) alone, ***versus*** ORIF *plus* arthroscopy. This is a retrospective case series of patients who have undergone ankle fracture ORIF +/− arthroscopy from July 2014 to July 2017 inclusive. Each patient's presenting radiograph was classified according to the *Lauge-Hansen* ankle fracture classification with subsequent correlation to intra-operative arthroscopic findings. Functional outcome at a minimum of one year was evaluated with the American Academy of Orthopaedic Surgeons (AAOS) metric. Twenty two patients underwent ankle ORIF plus arthroscopy (Group A) with a further 26 patients receiving ORIF alone (Group B). 1 in 3 supination-external-rotation type II (SER II) injuries possessed a concomitant syndesmosis injury or osteochondral lesion (OCL) on arthroscopy. 1 in 3 patients with an SER IV injury had an osteochondral lesion. The mean AAOS score achieved for Group A was 89.6 (±7.9) with the mean score for Group B being 82.0 (±13.7). In conclusion, ankle arthroscopy aids the diagnosis and treatment of ligamentous and osteochondral injuries not evident on plain film with subsequent superior short-term outcomes.

Keywords

Ankle Fracture, Arthroscopy, Osteochondral Injury, Syndesmosis, Lauge-Hansen, ORIF, Ligamentous Injury, Syndesmosis Disruption,

Persistent Ankle Pain, Post-Traumatic Arthritis

1. Introduction

Ankle fractures occur in 0.1% of the population and are among the most common injuries treated by orthopaedic surgeons [1]. Ankle fractures are traditionally treated with open reduction and internal fixation (ORIF) alone, which have good to excellent outcomes [2]. A minority of patients with ankle fractures develop persistent pain and impaired function following anatomic reduction [2]. Furthermore, 14% - 50% of patients develop post-traumatic arthritis following ankle fracture fixation [3].

These sequelae are thought to arise as a result of untreated ligamentous and/or chondral injuries [4]. There is emerging evidence to suggest that osteochondral lesions (OCL) sustained at the time of injury may be an independent prognostic indicator of functional outcome [5]. Indeed, the concomitant presence of chondral injury is not always evident on plain film studies and is often underestimated on higher imaging modalities such as CT or MRI [6].

With regard to identification of syndesmotic disruption: plain film imaging has shown to possess sensitivities of 58.3% [6] while MRI shows greater promise with sensitivities ranging from 93.1% - 100% [7]. Intra-operative testing of the syndesmosis using the *Hook* test or *External Rotation* test has also been found to under-diagnose ligamentous injury by up to 32% [8]. The ankle fracture pattern itself may help to predict the likelihood of possessing a severe OCL [9].

Ankle arthroscopy has been shown to aid in the *diagnosis*, *prognosis and treatment* of concomitant ankle pathology present in acute ankle fractures [7] [8] [9]. This study aims to identify the associated presence of intra-articular and ligamentous injury in acute ankle fractures in patients undergoing ankle ORIF and arthroscopy in our institute, over a two-year period. We further aim to correlate the presence of associated chondral or ligamentous injury present on arthroscopy with the *Lauge-Hansen* fracture pattern. Finally we aim to compare subjective functional outcomes at least one year post-operatively between patients who underwent ORIF alone *versus* ORIF plus arthroscopy—utilizing the American Academy of Orthopaedic Surgeons (AAOS) scoring metric.

2. Methodology

This is a retrospective single-surgeon case series of patients who have undergone ankle ORIF, and ankle ORIF with arthroscopy in the skeletally mature patient from July 2014 to July 2017. Institutional ethical approval was obtained. This patient cohort was identified via extrapolation of theatre record data. Anthropometric data for each patient was ascertained from pre-operative medical documentation. All patients underwent ankle ORIF by, or under direct supervision of the clinical lead Mr Thomas Bayar.

Ankle ORIF was performed under general or regional anaesthetic with the patient supine. A tourniquet was applied to the upper thigh in all patients and inflated to 350 mmHg following exsanguination of the lower limb. A direct lateral incision was performed for all simple distal fibular fractures with an accompanying medial incision for medial malleolus fixation when indicated. Fibular fixation was via a lag screw and a neutralization locking plate with the aid of an image intensifier. Posterior malleolus fixation was via a postero-lateral approach. Fixation was with a 1/3 tubular buttress plate for these fracture patterns. All patients were able to weight bear as tolerated post-operatively in a pneumatic walking brace (*Aircast Boot*®).

Ankle arthroscopy was performed following ORIF of the fibula. Arthroscopy was indicated for patients with unstable ankle fracture patterns *i.e.* patients with an increased medial clear space (MCS), patients with a combined tender medial ankle and radiographic supination-external-rotation injury type II, and in patients with a posterior inferior tibio-fibular ligament avulsion (PITFL) injury. Arthroscopy was performed in the supine position without the presence of a leg holder or distraction device. Standard antero-lateral and antero-medial ankle portals were utilised in all cases following outline of the superficial peroneal nerve as described in Stephens and Kelly [10].

A maximum allocated time of 10 minutes was allocated for each arthroscopy. The diagnostic criteria for a torn syndesmosis were as per Takao *et al.* [6]: an abnormal course or discontinuity of the ligament: a decrease in its tension: an avulsion at its attachment and a positive arthroscopic stress test [6]. Syndesmosis injuries were treated with a buttoned FibreWire (*Arthrex*, *Naples*, *Tightrope*®), placed from lateral to medial, 1.5 cm superior to the ankle joint surface with the aid of an image intensifier. No syndesmosis screws were utilised in this case series. Deltoid ligament injuries identified on arthroscopy were repaired with transosseous bone anchors. The presence of an OCL was recorded and debrided to stable margins. Wound closure in both groups was performed with a deep synthetic absorbable suture (*Vicryl*®), coupled with a synthetic monofilament subcuticular stitch (*Maxon*®).

Each patients presenting ankle radiograph was categorized according to the *Lauge-Hansen* classification. This classification was performed independently by the primary author (Mr. Ciarán McDonald) and the clinical lead (Mr. Thomas Bayer). Arthroscopic findings were correlated with the fracture pattern itself.

Complications following both arthroscopy and ORIF were identified from patients' medical records. Subjective outcomes were recorded utilizing the AAOS metric. D'Agostino Pearson omnibus normality testing was performed with subsequent non-parametric Mann-Whitney U testing comparing subjective outcomes for the two groups.

Statistical analysis was performed using *Stigmastat* statistical analysis software (Systat Software Inc.) for all statistical analysis; a value of $P < 0.05$ inferred statistical significance.

3. Results

3.1. Patients Demographics

In total, 22 patients underwent ankle ORIF plus arthroscopy (Group A) with a further 26 patients undergoing ORIF alone under care of the clinical lead from July 2014 to July 2017 inclusive (N = 48). Patients from both groups were closely matched with ASA grade and BMI (Table 1).

3.2. Lauge-Hansen Fracture Pattern and Associated Arthroscopic Findings: Group A

The majority of patients who underwent ankle ORIF plus arthroscopy (Group A) had a supination-external-rotation (SER) type IV (n = 9). The second most common fracture pattern was SER type II (n = 6), followed by an SER type III (n = 5). Only two patients in Group A had a pronation-external-rotation injury—type II and IV respectively (Table 2).

Of the patients in Group A with an SER II injury, 2 (33.3%) possessed a concomitant syndesmosis injury or OCL. All patients with a radiographic SER III injury had syndesmosis disruption identified on arthroscopy as well as one OCL

Table 1. Patient anthropometric data for Group A and Group B. BMI = body mass index, ASA = American Society of Anaesthesiology, M = male, F = female, SD = standard deviation.

Demographic	Group A (n = 22)	Group B (n = 26)
Age (±SD)	48 (±8.9)	52 (±9.4)
Gender	14F 8M	18F 10M
BMI (±SD)	28.6 (±3.4)	29.7 (±4.5)
ASA I	8	8
ASA II	14	18

Table 2. Lauge-Hansen ankle fracture classification and associated pathology identified on arthroscopy for patients in Group A. SER = supination external rotation, PAB = pronation abduction, PER = pronation external rotation, OCL = osteochondral lesion.

Lauge-Hansen Classification	No. of patients (n = 22)	OCL present	Deltoid Injury	Syndesmosis Injury
SER II	6	2	0	2
SER III	5	1	1	5
SER IV	9	3	4	9
PAB II	0	0	0	0
PER II	1	0	0	1
PER III	0	0	0	0
PER IV	1	0	0	1

(20%) and one deltoid injury (20%). All patients with SER IV injury (100%) had a syndesmosis injury identified on arthroscopy. A further three patients (33.3%) with an SER IV injury had an OCL present on arthroscopy with a further 4 (44.4%) having had a deltoid ligamentous injury evident on arthroscopy. In Group A, both patients with a PER pattern (both II and IV) had syndesmosis disruption evident on arthroscopy.

3.3. Lauge-Hansen Fracture Pattern: Group B

The most common ankle fracture pattern present in Group B was SER type II (53.8%) and SER type IV (34.6%). Only one PER (type III) was present in this cohort. A further two pronation-abduction type injuries were also present in Group B (Table 3).

3.4. AAOS Score

The mean (±SD) AAOS score (0-100) achieved for Group A was 89.6 (±7.9). The mean AAOS score achieved for Group B was 82.0 (±13.7). The mean follow up time for Group A was 20.9 (±8.0) months. The mean follow up time in Group B was 19.9 (±7.7) months.

3.5. Complications

No wound dehiscence or nerve injury was identified in either group.

4. Discussion

Unstable ankle fractures treated with anatomic reduction and internal fixation have traditionally resulted in good to excellent outcomes [2]. This is the case for the majority of patients and is disputed by few. A minority of patients do, however, go on to develop persistent ankle pain and subjective instability [2]. Work up for this cohort of patients can be both complex and time-consuming. Investigations with higher imaging modalities such as CT or MRI are generally performed to help identify the cause of such sequelae. Varying pathology has been

Table 3. Lauge-Hansen ankle fracture classification for patients in Group B. Abbreviations same as in Table 2.

Lauge-Hansen Classification	No. of Patients
SER II	14
SER III	0
SER IV	9
PAB II	2
PER II	0
PER III	1
PER IV	0

hypothesised to contribute to the cause of this persistent pain including OCL or ligamentous injury [4]. Thomas *et al.* identified OCL in 90% of patients with chronic ankle pain complaints following ORIF [11].

These injuries may not always be identifiable on plain film radiographs. Although MRI has shown high sensitivity and specificity in identifying these injuries, clinicians may not have access to, or funding for, such imaging in the pre-operative setting. Furthermore, underestimation of purely chondral injuries can also occur with either CT or MRI [6].

Ankle arthroscopy has been shown to be quick and effective means of identification of radiographically occult pathology. In this case series, 6 of the 22 patients (27%) were shown to possess an OCL. All OCL were present on the talar dome itself and were debrided until stable margins were identified. No OCL was identified on the tibial surface. Outcomes for these patients at a mean of 15.9 months were good to excellent with mean AAOS scores of 89.6 (±7.9). None of the patients in Group A reported persistent medial ankle pain of feelings of instability in the aforementioned follow-up period.

Aktas *et al.* retrospectively identified the incidence of OCL in ankle fracture types [12]. In this case series, 50% of the 48 patients involved possessed an OCL. Despite the presence of OCL (which were untreated) the mean AOFAS hindfoot-ankle score was excellent at 95.4 at a mean follow up of 33.9 months. One would expect a suboptimal subjective outcome in patients who have had a concomitant OCL with an ankle fracture. This may be as a result of the time point used to assess functional outcome. Likely, issues arising from associated OCLs may only become evident at medium to long-term follow-up. Long term functional outcome would be an essential identifier and highlights a similar limitation in our case-series.

We found the presence of an OCL to be most commonly associated with an SER type IV fracture pattern. The presence of a concomitant syndesmosis disruption was suggested to be associated with a higher risk of talar OCL [13]. Hintermann *et al.* describe an increased incidence of OCL in a pronation-external-rotation (PER) injury compared to a supination injury (SER) and claim this is due to an increased force required in a PER injury [9]. Leontaritis *et al.* found 73% of patients with unstable ankle fractures possess an associated OCL [13]. In the latter patient cohort, the presence of OCL was more likely to be present in both Lauge-Hansen SER IV as well as all PER injuries [13]. Indeed, a type IV fracture was between 8.1 and 9.7 times more likely to possess two or more chondral injuries than a type II fracture pattern [13]. This increased incidence of OCL may contribute towards the long-term 10-fold increase in post-traumatic degenerative arthrosis found in a type IV injury compared to a type II injury [13]. Although we found OCLs to be mostly present with concomitant type IV SER fracture patterns, only two patients who received ORIF *plus* arthroscopy had PER type injuries. As such we cannot conclude from this study that SER fracture patterns are more associated with OCL than PER type injuries.

Taga *et al.* identified the association of OCL with lateral ligamentous instability [14]. Here, Taga *et al.* identify patients with OCL > 50% cartilage thickness to develop persistent ankle pain [14]. In this study, the patients' subjective pain-location correlated accurately with the anatomical location of the OCL [14]. This highlights a limitation in our case-series where we fail to accurately identify the thickness of the OCL identified on arthroscopy. In our case-series there was no overall statistical significance in terms of AAOS score or for patients who have had ORIF alone versus ORIF with arthroscopy.

Stufkens *et al.* conducted a large (288 ankles) prospective study with a 12.3 year mean follow up [5]. This is one of the few studies where long term outcome and radiographic evaluation were identified in patients who have undergone ORIF and arthroscopy. It revealed that patients with OCL would have a 5 - 1 likelihood of having a sup-optimal long-term clinical outcome compared to patients without OCL at initial ankle ORIF [5].

In a recent publication, Da Cunha *et al.* retrospectively assessed 116 ankle fracture patients who also received arthroscopy at the time of fixation [15]. In this study, small and large OCL were acutely treated with debridement or microfracture with bone marrow aspirate concentrate [15]. As in the study performed by Leontaritis *et al.* [13], the presence of complete syndesmosis disruption was associated with a high likelihood of OCL, as was dislocation [15]. Albeit a one-year post-operative follow up, statistical significance was demonstrated in QOL measures between patients with a full-thickness lesion and those without a full-thickness lesion [15]. This is one of the only studies demonstrating superior short term (1 year) outcome scores in patients without major OCL [15]. One can postulate from the above that an ankle fracture in the presence of syndesmosis disruption should undergo arthroscopic assessment and treatment in the acute setting to help offset any potential adverse complications from associated OCL.

The addition of arthroscopy also aided in identifying ligamentous injury not evident on plain film. We found two patients with a radiographic SER II injury to have syndesmosis disruption present on arthroscopy (33.3%). Traditionally, syndesmosis disruption may be identified on presenting plain film radiographs or by intra-operative stress testing such as the *Hook test*. Takao *et al.* identified sensitivities of 44.1% and 58.3% respectively for the detection of syndesmosis disruption on AP ankle and mortise plain films respectively [7]. Furthermore, identification of syndesmosis injury via the intra-operative *Hook* test has shown sensitivities as low as 25% with varying inter-observer reliability [16]. Beumer *et al.* has shown that up to 25% of syndesmosis injuries can be missed when utilizing intra-operative stress testing [17]. Similar findings by Lui *et al.* identified missing syndesmosis disruption via intra-operative testing by 36% [8].

The Lauge-Hansen fracture classification helps alert the physician to a disrupted syndesmosis based on the fracture pattern. With regard to SER injuries: syndesmosis disruption would be expected in type III and type IV fracture patterns. In our study, this was confirmed by arthroscopic evaluation (see **Table 2**), with 100% of patients with SER III and IV having syndesmosis disruption. Furthermore, we found that 2 out of 6 patients who presented with SER II injury had arthroscopic evidence of syndesmosis disruption. Thus, 33.3% of SER II patients had an undiagnosed syndesmosis injury when using the Lauge-Hansen classification alone. The addition of arthroscopy in these circumstances aids the diagnostic accuracy of ligamentous injuries sustained that may be initially radiographically occult. Only two patients had a pronation type injury in this case-series. Both patients had confirmation of syndesmosis disruption on arthroscopy with subsequent fixation.

There are several limitations to our study. Firstly, this is a retrospective case series. Although comparison was made between patients who underwent ORIF and arthroscopy versus ORIF alone, no randomisation process allocated patients to either group. Ankles that were deemed more "unstable" underwent arthroscopy. Furthermore, only short term follow up was performed for both groups of patients. It may be likely that significant changes brought about by arthroscopy may only become evident in a medium to long-term outcome assessment.

5. Conclusion

From our study, we can conclude that the addition of ankle arthroscopy in patients undergoing ankle ORIF aids in the identification and management of ligamentous and osteochondral injuries not evident on plain film. Excellent short term outcomes have been identified in patients who undergo ankle ORIF and arthroscopy.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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