



Pseudoaneurysm following ankle arthroscopy: a systematic review of case series

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Abstract

Background/objective Pseudoaneurysms (PA) are rare complications following ankle arthroscopy (AA). Delay in diagnosis is reported to be frequent and could lead to serious complications. Evidence synthesis on the clinical context of such complication lacks in the literature.

Methods A systematic review is conducted to locate all relevant papers. In total, 23 case reports were included in the review. Data of 23 patients with a mean of 40.9 ± 10.3 years were extracted and analyzed. Outcomes included comorbidities, portals and procedure types performed during AA, PA location and size, time to diagnosis and treatment, and therapeutic modalities.

Results The results showed that d-ATA and the dorsal pedis artery (DPA) were involved in 18 and 4 cases, respectively. A single case of PA of the fibular artery was described. The mean PA size was found to be $4.2 \times 3.9 \times 2.1$ cm. Five of the 14 patients (35.7%) with a reported detailed medical history were treated for a cardiovascular or hemostasis condition. Delay in PA diagnosis was found to be at a mean time of 50.45 ± 74.6 days. The most commonly reported surgical indications were anterior synovectomy and removal of anterior osteophytes. Ligation was the most common procedure in treating PA.

Conclusion While portal placement might be a minor factor, the variability of the d-ATA and/or DPA anatomical position and its affection with foot position and distraction during AA could play a role in the arterial injury. Synovectomy and removal of anterior, particularly big-sized, osteophytes could be considered as risk factors as well. A state of hypocoagulability might affect injury healing and consequently PA formation. PA diagnosis should be raised whenever a non-resolving or pulsatile swelling over a portal incision is observed.

Keywords Ankle arthroscopy · Artery injury · Anterior tibial artery · Dorsalis pedis artery · Pseudoaneurysm

Introduction

Most pseudoaneurysms (PA) are iatrogenic usually resulting from vascular interventions, while some could result following joint arthroscopy [1]. Most PA cases have involved the popliteal vessels after knee arthroscopy [1]. Since its first description by Takagi in 1939 [2], ankle arthroscopy (AA) has become an important diagnostic and therapeutic tool

for the treatment of different ankle and subtalar conditions [3]. Iatrogenic complications following AA procedures have been reported to range from 9 [4] to 17% [5] with nerve injuries being the commonest. Though rare, vascular injuries after AA are occasionally published with an incidence estimated at 0.008% [3]. Most case reports stated PA as the most frequent vascular complication where the distal branch of the anterior tibial artery (d-ATA), or its terminal branch, the dorsalis pedis artery (DPA), was the most commonly involved (Table 1).

Neurovascular complications following AA are thought to be related to the placement of the portals, instrumentation or the procedure type [6, 7]. A recent meta-analysis by Yammine et al. [6] found that the anterocentral portal (AC), as opposed to other ankle portals, was associated with a significant higher risk of nerve and vessel injuries and missed injuries during arthroscopic simulation on cadavers. The DPA was found to be at a mean distance

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Table 1 Extracted data from the included studies

Studies	Number of cases	Sex	Comorbidities	Age	Portal	Procedure	Distraction	Injured artery	Time to surgery	Initial/later diagnostic tools	Size of pseudoaneurysm (cm)	Treatment
O'Farrell et al. (1997)	1	Male	Prosthetic aortic valve	30	AM/AL	Removal of anterior tibiotalar osteophyte	None	d-ATA	7	US/angiography	2.0×2.0	Ligation and anastomosis
Salgado et al. (1998)	1	Female	None	12	AM/AL	Diagnostic arthroscopy	None	d-ATA	60	US/angiography	2.0×2.5	Ligation
Mariani et al. (2001)	1	Female	None	50	AM/AL	Anterolateral synovectomy	Invasive distraction	d-ATA	7	MRI/US	2.0×2.5	Ligation vein graft
Darwish et al. (2004)	1	Female	None	70	AM/AL	Anterior synovectomy	None	d-ATA	42	Clinical only	4.0×4.0	Ligation
Slysko et al. (2006)	1	Male	NA	31	NR	Anterior cartilage repair	None	DPA	30	MRI	2.8×2.0	Vein graft
Kotwal et al. (2007)	1	Male	Hemophilia A	20	AM/AL	Removal of anterior tibial osteophyte with extended AM portal debridement	None	d-ATA	10	US/angiography	2.8×1.0	Compression
Jang et al. (2008)	1	Male	None	25	AM/AL	Anterolateral synovectomy ATFL recon	Noninvasive distraction	d-ATA	56	CTA	3.5×2.8×1.9	Ligation
Sadat et al. (2008)	1	Female	None	48	AM/AL	Synovectomy + removal of osteophytes	None	d-ATA	21	US	3×3	Endovascular coil embolization
Kashir et al. (2009)	1	Female	None	26	AM/AL	Meniscoid lesion of TF joint	None	DPA	28	Surgical exploration	NA	Ligation
Ramavath et al. (2009)	1	Female	Rheumatoid arthritis	39	AM/AL	Anterolateral synovectomy	None	d-ATA	21	US/angiography	3.0×6.0	Embolization
Brimmo and Parekh (2010)	1	Male	None	36	AM/AL	Synovectomy microfracture + removal of anterior osteophyte with extended AL portal	None	d-ATA	77	MRI/US/angiography	NA	Embolization
Jacobs et al. (2011)	1	Female	Atrial fibrillation	63	AM/AL	Synovectomy	Noninvasive distraction	d-ATA	7	US/angiography	NA	Ligation
Verbrugge et al. (2011)	1	Female	NA	15	AM/AL	Synovectomy + removal of lateral osteophyte	None	d-ATA	70	US/angiography	3.5×4.7	Ligation

Table 1 (continued)

Studies	Number of cases	Sex	Comorbidities	Age	Portal	Procedure	Distraction	Injured artery	Time to surgery	Initial/later diagnostic tools	Size of pseudoaneurysm (cm)	Treatment
Chun et al. (2012)	1	Female	NA	16	AM/AL	Synovectomy	None	d-ATA	2	Angiography	8.7×5.9	Ligation
Schaarschmidt and Hauser (2013)	1	Female	NA	58	NR	NR	None	d-ATA	NA	MRI/US	15×9	Endoscopic thrombectomy
Jeffery et al. (2014)	1	Male	Gout	80	NR	NR	None	d-ATA	32	US	3.2×3.2	Ligation
Kwon et al. (2014)	1	Male	NA	40	NR	Synovectomy	None	DPA	56		5×5	Vein graft
Battisti et al. (2015)	1	Female	None	66	AM/AL	Diagnostic	None	Peroneal artery	84	CTA	NA	Ligation
Chamseddin and Kirkwood (2016)	1	Male	Hemophilia A	35	AM/AL	Removal of anterior tibio-talar exostosis Synovectomy	None	d-ATA	49	Angiography	3.5×6.0×3.2	Ligation
Wiske et al. (2016)	1	Male	Hypertension	52	AM/AL	Removal of talar and tibial osteophyte with extended AM portal	None	DPA	60	MRI	6×6 (ruptured)	Repair
Davis et al. (2017)	1	Female	NA	53	NR	Synovectomy + removal of osteophytes	None	d-ATA	365	MRI	4×4	Vein graft
Qaderi et al. (2017)	1	Male	NA	57	NR	Removal of osteophyte	NR	d-ATA	7	US/angiography	3×3	Endovascular coil embolization
Tonogai et al. (2017)	1	Male	None	19	AM/AL	Removal of anterior osteophytes + synovectomy	Noninvasive distraction	d-ATA	19	MRI	2.5×2.2×1.3	Anastomosis

CTA computed tomography angiography, d-ATA distal anterior tibial artery, DPA dorsalis pedis artery, AM anteromedial, AL anterolateral

of only 2.1 ± 1.7 mm from the AC portal with an injury/missed injury frequency of 20% [6]. However, vascular injuries have been reported in the literature after using standard anteromedial (AM) and anterolateral (AL) portals (Table 1). Variations of the anatomical location of the distal ATA/DPA and procedures involving the anterior aspect of the ankle joint have been advanced as risk factors for ATA injury [8–10]. Pseudoaneurysm formation after ankle arthroscopy is a condition hard to recognize, and the time frame to diagnosis can range to several months. Delay in treatment can lead to hemarthrosis, compression neuropathy [8] and compartment syndrome [11]. When untreated, the PA might rupture leading to hemorrhage and hemodynamic instability [11].

The aim of this review is to systematically collate the published clinical cases of PA following AA in order to identify the vascular structures at risk and the clinical context of such injury. Potential associations with specific portals and procedure types will be also investigated.

Methods

Search strategy

An electronic literature search was conducted via Medline and Embase from inception to December 2017. Boolean combination of the following terms [(arthroscopy OR arthroscopic) AND (foot OR ankle) AND (pseudoaneurysm OR (vascular AND injur*))] was used to locate a maximum number of relevant articles.

Study selection criteria

Inclusion criteria were limited to studies reporting PA following ankle arthroscopy. Studies related to PA following foot and ankle injuries and open surgical procedures were excluded. No restriction was imposed on language, date, or age. Titles and abstracts were initially screened, and full-text articles were obtained.

Types of outcome

Since it is expected that all included studies are case reports, and all relevant outcomes in relation to the demographic and clinical contexts were studied. Outcome types are the following: demographic results (age, gender, comorbidities, indications for AA, and time to diagnosis), type of the involved artery, portal types, type of AA procedure, and therapeutic management.

Data collection

In preparing this review, we adhered to the meta-analysis of observational studies in epidemiology (MOOSE) guidelines [12].

Data extraction

A data extraction sheet was used to report and summarize all relevant details of the studies. Initially, one author extracted the d-ATA, which was later reviewed jointly to produce agreed accurate d-ATA. Disagreements were resolved by consensus. Data extraction included sample size, age, gender, comorbidities, indications for the surgery, portal approaches, type of AA procedure, clinical presentation and diagnostic tools, type and size of the injured artery, clinical presentation, and PA treatment.

Data analysis

Mean \pm SD and frequency values were calculated for the appropriate variables using the StatsDirect software. A narrative synthesis was conducted whenever quantitative data were limited.

Results

Search results

The search strategy yielded 121 records. After removing duplicates, 25 abstracts were deemed to be of interest, out of which 18 case reports were relevant to our review. Reference checking yielded another 3 relevant studies. In total, there were 23 clinical case reports included in the review. All but two were in English. Extracted data of the included studies [7–10, 13–31] are summarized in Table 1.

Demographic results

Age and gender

An equal gender distribution was found with an age ranging from 12 to 80 years and a mean of 40.9 ± 10.3 years.

Comorbidities

Medical history was lacking in 9 cases (39%). Out of 14 cases reporting detailed medical history, eight patients (57.14%) had no underlying disease and six (42.8%) were found to have comorbidities. In five cases, comorbidities

(35.7%) were related to cardiovascular or hematological conditions such as hemophilia A, gout, prosthetic aortic valve replacement, atrial fibrillation, and hypertension.

Clinical presentation and diagnostic tools

Non-resolving swelling and/or pulsatile mass over one of the portals were present in all reported cases. All cases reported the time to diagnosis and PA treatment; the mean time for PA diagnosis was 50.45 ± 74.6 days (range = 2–365 days).

The diagnosis of PA was raised clinically in only 6 cases (26%). In one study, the clinical signs were considered sufficient to confirm the diagnosis [16]. Ultrasound and MRI were the most frequent initial diagnostic tools. Angiography as a subsequent tool was mostly used to PA diagnosis (Table 1).

Injured arteries

A single case (4.3%) of fibular artery injury was reported. In all other cases, 22 out of 23 (95.2%), the d-ATA (18 cases) or its terminal branch, the DPA (4 cases), were involved.

Size of PA

Nineteen cases reported the size of the PA. The mean size of pouch was found to be $4.2 (\pm 3 \text{ cm}) \times 3.9 (\pm 2 \text{ cm}) \times 2.1 (\pm 0.9 \text{ cm})$, all diagnostic tools combined.

Portal types

None of the included studies reported the use of the AC portal. When reported, the AA procedure was always performed through the standard AM and AL portals.

In 3 cases (13%), an extension of one of the anterior portals was performed for removal of big-sized anterior osteophytes.

Procedure types

The most commonly reported surgical intervention was anterior synovectomy which was noted in 13 studies (56.5%); either as a single procedure in 6 cases (26%) or concomitant with another procedures such as the excision of an anterior osteophyte in 3 cases (13%), anterior tibiofibular ligament repair in 1 case (4.3%), or excision of a lateral osteophyte in 1 case (4.3%). The second commonest procedure was the excision of an osteophyte either anterior in 4 cases (20%) or lateral in one case (5. %). The excision of an anterior osteophyte was performed as a standalone intervention in 2 cases (10%) and associated with a synovectomy in another 2 cases (10%). Types of surgical treatment are shown in Table 1.

Treatment types

Proximal artery ligation was the most common procedure in treating PA following AA; it was used in 12 cases (57%). In ten cases (43.4%) ligation was performed as a standalone procedure, and in 2 cases (8.6%) it was combined with an anastomosis (1 case, 4.3%) or associated with vein grafting (1 case, 4.3%). Embolization was the second most common procedure reported in 4 cases (17.4%). Recovery was uneventful in all cases but three; the 3 patients necessitated a second vascular surgery which was definitive in all cases. Table 1 summarizes the treatment modalities of the included cases.

Discussion

Summary of main findings

Injuries to the d-ATA seem to be rare but not exceptional. Our systematic review located 11 more relevant papers compared to the 12 papers found in a recent review of the literature [3]. In sum, twenty-three cases were reported over 20 years (1997–2017). It is likely that not all PA complications were published and that the number of PA following AA is higher. When analyzing the results data of the review, some risk factors for PA occurrence could be suggested: portal location and its relation to d-ATA anatomy, surgery type (such as synovectomy and osteophyte resection) involving the anterior area of the ankle joint, foot position and distraction, cardiovascular medication and hemostasis status. Though non-resolving and/or pulsatile swellings were consistent clinical signs, the delay of 57 days to PA diagnosis was concerning.

Portal placement and ATA anatomy

The d-ATA/DPA is usually in close relationship to the anterior ankle capsule where the artery runs deep to the superior and inferior retinaculum [32]. Damage is thought to occur at portal insertion, via instrumentation through the portals, or by therapeutic manipulation in the joint [7]. Portal placement in ankle arthroscopy has been found to play a major role in neurovascular injuries [6]. Even though the anterior approach has been favored over the posterior approach, vascular complications were reported to occur with anterior portals. The anatomical variability of the d-ATA could increase the risk during anterior portal placement [6]. In fact, it is reported that in 5.5% of the population the d-ATA is deviated laterally, whereas it is deviated medially in 3.5% [33, 34].

Additionally, in 58% of cases a branch of the d-ATA was found to cross the level of the ankle joint [8]. Out of these,

31.5% were lateral, 21% medial, and 5.5% bilateral. Son et al. [34] reported that in 2% of the population, the d-ATA was lateral to both the posterior tibial tendon and extensor digitorum longus, while in 4.2% it had a normal position but the branching of this vessel was lateral to both structures. The same author stated that up to 6.2%, the d-ATA or one of its branches is considered at risk of injury. As for the DPA, it might arise from the peroneal artery in 2–12% of cases [7, 33] or it can take an aberrant course along the anterior ankle joint in 1–3% of cases [33]. Vijayalakshmi et al. [35] found DPA to have a normal course and branching pattern in 56%, variation in origin in 8%, variation in branching pattern in 16%, absence of the artery in 2% and duplication in 2% of the specimens studied. It is worthy to note that none of the included reported detailed interpretation in relation to the anatomical nomenclature of the distal branches of the anterior tibial artery. Those who reported DPA as the location for PA did not state anatomical references or definitions as to compare them with d-ATA.

Though none of the included studies in the review mentioned a causal effect between portal placement and PA, none also explicitly excluded a possible anatomical variation of d-ATA or one of its branches as a risk factor for their case report. Additionally, while it was found to be at a mean distance of 2.1 ± 1.7 mm from the AC portal, the d-ATA was at a safe distance from both AM and AL portals with no occurrence of DPA injury or missed injury when these portals were used [6]. However, this review showed that all PA post-AA were encountered using the classical AM and AL portals; none reported the use of the AC approach. This might indicate that portal placement as a single factor could have played a minor role in PA development during AA. In fact, only 2 PA out of the 23 (9%) occurred after a diagnostic AA; one reporting an injury to the fibular artery and the other to the d-ATA. In these 2 cases, portal placement is likely linked to the observed vascular injury.

Surgery type

Our review shows that all AA procedures were performed in the anterior compartment of the ankle joint, mainly anterior synovectomy, excision of anterior osteophytes, or both. It has been demonstrated that at the level of the talar neck, the d-ATA is only 2.3 mm away from the anterior ankle joint. Such anatomical relationship is thought by some to be also a risk factor during resection of an anterior talar osteophyte [7, 36]. The need for skin extension of one of the anterior portals for better excision of big-sized osteophytes was reported in 3 cases (13%). Further dissection and instrumentation during the removal of big anterior osteophytes could have contributed to the injury of the neighboring d-ATA. Knowing the intimate relationship between the d-ATA and the anterior capsule, synovectomy or osteophyte removal at the

anterior part of the ankle joint could be considered a risk factor for d-ATA/DPA injury.

Foot position and distraction

Foot position could also play a role in arterial injury. A cadaveric study done by Salvi et al. [37] found lesser vascular injuries during AM portal placement when the foot is placed in plantar flexion. This result was thought to be due to increased tautness of the anterior tibial artery during plantar flexion which minimized its risk of injury [37]. None of the included cases in the review reported posterior impingement or posterior talar conditions, where plantar flexion is needed for better visualization. The working area was mostly anterior with the need of dorsiflexion for better instrumentation. While allowing more easiness in manipulating the instruments, the dorsiflexion position might encourage surgeons to use motorized or other biting instruments more anteriorly, and consequently closer to the artery. Excessive distraction or compression of the strap on the artery that is placed during distraction over the anterior capsule has also been linked to ATA involvement [3]. In contrast with the findings of Salvi et al. [37], Jang et al. [16] stated that plantar flexion associated with ankle strap placement for joint distraction could decrease the distance between the anterior tibial artery and the anterior ankle capsule. Our results indicate that distraction might be a risk factor for arterial injury of the ATA; four out of the included 23 studies (17.4%) reported the use of a sort of distraction. Further anatomical research is needed to evaluate the variations of the d-ATA location in relation to distraction and foot position.

Comorbidities

Five of the 14 patients (35.7%) with a detailed medical history were treated for a cardiovascular or hematological condition. Another case had rheumatoid arthritis. A hypocoagulability state induced by medication or a coagulation factor deficit might impact negatively the healing of an arterial injury. Further research is needed to evaluate the impact of an abnormal hemostasis on a vessel injury.

Time to diagnosis and clinical signs

PA seems to be a condition hard to recognize, and the time-frame to diagnosis can range up to several months. The observed delay of 57 days in diagnosing PA following AA is concerning. We believe that this complication should be kept in mind whenever there is non-resolving swelling over a portal incision. Palpation is warranted to look for pulsation. Swelling and pulsatility over a portal incision were found to be consistent signs in all included studies. In case of a doubt, a vascular investigation should be sought to avoid any diagnostic

and therapeutic delay. Wiske et al. [25] reported one case of ruptured PA where the patient had to undergo a lifesaving operation.

Treatment modalities

The treatment of a PA is usually surgical. Ligation with aneurysm resection [7, 15] has been proposed in cases where adequate collateral blood supply is available or when the planar arch is intact [38–40]. Artery repair by end-to-end anastomosis [40, 41] or grafting (9) to preserve the normal anatomical blood flow is thought to be beneficial in preparation for the occurrence of peripheral vascular disease (PVD) later in life or in the setting of patients with PVD occurs [41, 42]. Non-surgical as well as mini invasive procedures such as external or ultrasound-guided compression [16, 43], ultrasound-guided thrombin injection [44] and percutaneous endovascular stenting or coil embolization [45] have been used. While ligation was the commonest treatment type, all above-cited therapeutic modalities have been reported in this review. Due to the rarity of the condition, clear guidelines for the treatment of ankle PAs are yet to be established.

Limitations

The major limitation of this systematic review is the study design of the included papers. All studies were case reports. However, that is usually the case for very rare clinical diseases or conditions. While offering an acceptable ground for better understanding of rare conditions, systematic reviews of case reports could draw basic conclusions or assumptions that could serve to lead future research.

Implications for practice and research

The clinical implication of this review is the need to raising awareness of this potential serious complication after AA procedures. The diagnosis of PA should be promptly brought up when non-resorbing and/or pulsatile swelling is noted on a portal incision site after AA.

In this paper, some factors were located and considered plausible risk factors inducing the vascular injury and consequently PA formation. The research implications would steer investigations to look for the impact of the foot position and distraction during AA on the anatomical position of the ATA, alternative technical tips for synovectomy and osteophyte removal, and the relationship between hemostasis and PA formation in case of arterial injury.

Conclusion

Pseudoaneurysm after ankle arthroscopy is not exceptional. The distal anterior tibial artery and the dorsalis pedis artery are the vascular structures mostly at risk of developing a PA. All reported PAs occurred following the use of standard anteromedial and anterolateral portals. Synovectomy and osteophyte removal at the anterior aspect of the ankle joint could be risk factors. Dorsiflexion and distraction during AA procedure might also contribute to the arterial injury. A hypocoagulability status might impact the healing of a vascular injury which could lead to PA. A non-resolving edema or a pulsatile swelling over a portal incision is found to be consistent clinical signs. The observed long delay in diagnosing PA following AA is concerning. Future research is needed to investigate the relationship of anterior arteries and the capsule joint in different foot position and in distracted ankles.

Compliance with ethical standards

Conflict of interest None.

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