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## Case Report

# Penetrating Proximity Wounds and Minimal Arterial Injuries may not be so Benign

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### ARTICLE INFO

#### Article history:

Received: 6 August, 2019

Accepted: 26 August, 2019

Published: 2 September, 2019

### ABSTRACT

There is a well-established body of literature in the management of vascular injuries that underscores the benign natural history of minor so-called occult arterial injuries. The standard approach for the management of the proximity extremity wound has evolved into one of watchful waiting. We present a case of an occult arterial injury that declared itself with an acute arterial bleed after about 30 hours of observation indicating that caution and preparation remain critical in the management of these patients.

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## Introduction

Historically, the management of the penetrating extremity wound in proximity to arterial structures has changed over the years. We have moved from a policy of mandatory exploration in the 1980's to one of careful observation in the presence of an entirely normal ipsilateral peripheral vascular exam [1, 2]. This concept is based on the fact that if there was an underlying arterial injury it is by definition minor because there is no clinical manifestation of that injury. There is sufficient evidence in the literature to support the fact that a minor arterial lesion, if present, has a high likelihood of healing on its own. Therefore, if there is a clinically occult arterial lesion that will heal on its own it is not so crucial to identify it with further radiographic studies.

We present a case of a stab wound to the medial thigh with an occult injury to the superficial femoral artery (SFA) that was treated initially with 24 hours of observation. Eight hours after discharge the patient presented with a large contained pseudoaneurysm of the right thigh requiring operative intervention consisting of direct arterial repair. As with any good algorithms there is always the potential for an outlier and this case of a stab wound in proximity to the right mid-SFA will serve as a reminder that caution and follow-up is critical to ensure good outcomes in the trauma patient.

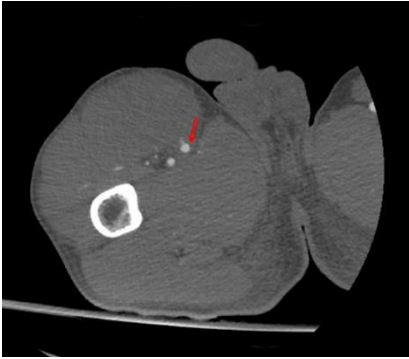
## Case Review

The patient was a 23-year-old gentleman with a stab wound to the medial aspect of the right mid-thigh. According to the pre-hospital providers there was a significant amount of blood at the scene. His initial blood pressure was 111/68 with a heart rate of 110 and a respiratory rate of 16. There was a single 2 cm stab wound in the right medial thigh without hematoma or active bleeding. The pedal pulses in both lower extremities were normal and equal to palpation and all compartments were soft. Ankle Brachial Indices (ABIs) were normal and equal bilaterally. The lactic acid was 5.0 with the remainder of the panel demonstrating normal values. A CT Angiogram was performed and read as normal (Figure 1). The wound was packed superficially, and the patient was admitted to hospital for 24 hours of observation. There was no change in the appearance of the wound or the normal peripheral vascular exam. He was discharged after an uneventful stay with plans for follow up in the Trauma Clinic within the week. He was advised to use crutches to help with partial weight-bearing and he left without waiting for their delivery and further instruction from physical therapy.

Approximately eight hours after discharge the patient noted increased pain in his thigh and bleeding from the right thigh wound while walking. He returned to the emergency department with stable vital signs and a small amount of bleeding from the wound with a prominent fullness of

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the right anterior thigh. He had normal bilateral distal pulses. Computed Tomographic Angiography of the leg with intravenous contrast revealed an 8 cm pseudoaneurysm arising from the mid-superficial femoral artery (Figure 2). There was no compromise in the blood flow distally beyond the take-off of the pseudoaneurysm. In the Operating Room the operative team found layered clot within the thigh musculature and after proximal and distal control of the SFA was obtained the approximate 5 Fr laceration to the anterior portion of the SFA was closed primarily using interrupted 5-0 Prolene sutures. The wound was closed over drains and he was discharged without complication on postoperative day 5.



**Figure 1:** Single stab wound to the right superficial femoral artery (SFA) read as normal. The small anterior extension was interpreted as a branch vessel. Note lack of air and hematoma in the regi.



**Figure 2:** Single stab wound to the right superficial femoral artery (SFA) 24 hours after admission and eight hours after discharge.

## Discussion

The treatment of vascular injuries has improved markedly since the early attempts at identification and repair that were outlined by DeBakey's work in the closing months of World War II [3]. The hard signs of vascular injury include active arterial hemorrhage, a localized thrill or bruit, limb ischemia and/or large, possibly pulsatile, hematoma in the region of the injury and are obvious indications for arterial repair. The directed blood product resuscitation, wide skin preparation, proximal and distal control followed by well described techniques of arterial repair will dictate the optimal results. The role of endovascular intervention for arterial injury is also undergoing evolution as more and more peripheral vascular interventions are feasible for certain arterial injuries.

The evaluation and subsequent treatment of proximity injuries has undergone a similar thoughtful approach over the years since a number of initial major contributions in the late 1980's and early 1990's [4-10].

Prior to that time the standard approach had been mandatory exploration of those wounds that had coursed through tissue in close proximity to a named arterial structure. The yield of identifying an arterial injury in this fashion was low and the risk of a negative exploration was high. The incidence of vascular injuries by proximity alone hovered in the 6-21% range based on exploration hence there were many patients who were subjected to unnecessary operations.

A number of articles followed confirming the adequacy of arterial imaging with angiography to rule in or out extremity arterial injury in an effort to limit the number of negative limb explorations. This angiographic approach reduced the incidence of negative arterial explorations but nonetheless subjected many patients to the cost and invasiveness of an angiographic study for a yield of about 20% true injuries. These so-called positive angiographic findings would have dictated mandatory exploration at that time. However, in many cases it became clear that what was positive for injury on the angiogram may not require repair because these lesions were clinically not apparent by physical exam and were described as occult lesions. Hence the clinical significance of a positive angiographic finding was called into question by a number of investigators who had identified what appeared to be a benign natural history of a number of minor arteriographic findings that included spasm, minor intimal flaps with less than 75% luminal compromise and even small pseudoaneurysms.

Because these clinically occult arterial lesions seemed to have a benign natural history and were shown angiographically to heal on their own, the argument ensued that there likely was no reason to even look for these lesions through further testing. This approach does not apply to those situations in which there are either hard or soft signs of vascular injury which would dictate a more in-depth evaluation. It should be pointed out that the utility of physical exam alone in the evaluation of penetrating extremity wounds does not apply to wounds in proximity to the shoulder or the thigh where major vascular structures are deeper and have additional major branches such as the profunda femoris or profunda brachii that could well be injured without obvious physical findings or downstream manifestations on blood flow [11].

These studies have formed the basis of our practice today in the initial evaluation and decision-making in the treatment of extremity vascular injuries for the past 20-plus years. The only change has been the evolution and improvement in Computed Tomographic (CT) angiography which has become the preferred imaging for the patients with suspected injury to arterial structures. In the early 2000's, the widespread availability of 64-row multi-detector CT technology essentially replaced the need for the more invasive formal angiogram. This technology demonstrated a similar ability to detect these minor and major vascular injuries with several caveats that limit the quality of the evaluation. Potential pitfalls of the CT technology include inadequate contrast load at the site of the suspected injury, heavy calcification of atherosclerotic vessels, motion artifact, streak artifact from shrapnel in the tissues, and image degradation from radiopaque hardware such as joint replacements.

In this case the patient did not demonstrate any hard signs of a vascular injury on initial presentation. In addition, there were no soft signs of injury as in moderate hematoma, reduced but present distal pulses or a reduction in the Ankle-Brachial Index (ABI) to less than 0.90 that would

suggest soft signs of arterial injury. Nonetheless, the CT Angiogram was performed and read out as negative for injury. Further review of the film indicated that there was indeed an angiographic finding of a wisp of a small 5 mm pseudoaneurysm coming off the anterior portion of the mid-SFA. Many practitioners would treat that small pseudoaneurysm as a clinically occult minor vascular injury that is worth observation but would not elect immediate operative intervention. This patient underwent the requisite 24-hour observation period without change and was discharged with clinic follow up within the week. He had no particular history of a bleeding tendency and was on no anticoagulants that would place him at undue risk. It is unclear as to his activity level while he was out of hospital but it is clear that he never pursued the option for crutches and partial weight-bearing as ordered. He returned to the Emergency Department in short order with a potentially life-threatening injury that was contained within the thigh musculature and underwent immediate operative repair.

The management of traumatic pseudoaneurysms has been examined over the years with respect to the iatrogenic pseudoaneurysms from arterial catheterization procedures. Kent et al. had indicated that physical examination is very accurate in the diagnosis of traumatic pseudoaneurysms of the common femoral arteries, but this is also a function of the more superficial nature of those vessels [12]. The wounding mechanism in this case is not necessarily similar to that of a vascular access case but there are similarities in that there is a full-thickness discrete injury to the wall of the vessel with the extraluminal flow of blood contained by the perivascular tissue. The management choices in the iatrogenic femoral pseudoaneurysm are observation versus a more active intervention whether by ultrasound-guided thrombin injection or open surgical repair. Kresowik et al. described their experience with seven pseudoaneurysms that ran the gamut from 1.3 to 3.5 cm in size and all thrombosed spontaneously in less than a four-week observation period [13]. These data support those in the trauma literature indicating that minor arterial injuries may heal. However, not all series have reported such outstanding results as Kent et al. found that only two-thirds of femoral pseudoaneurysms underwent spontaneous closure within a six-week time frame. In the report by Kent et al. only 9 of the 16 cases underwent spontaneous thrombosis and size did not seem to be a determining factor as to which pseudoaneurysm would be likely to thrombose. In a later study 11 patients were studied with duplex to detect criteria for spontaneous closure. The length of the neck predicted earlier successful spontaneous occlusion in those with a neck greater than 0.9 cm as opposed to those with shorter neck length [14]. In this case there was no real appreciable neck length as the pseudoaneurysm itself was so small.

This trauma case calls into question the validity of the current approach of physical exam only for the evaluation of clinically occult proximity wounds. The current algorithm that many have practiced over the years is worthwhile but not bullet-proof. In most facilities the CT Angiogram might not have been done in this case. The fact that he had a 5 mm pseudoaneurysm would indicate that this is a minor injury and would be worth following but not necessarily dictating a need for immediate intervention. One of the original studies that probed the question of the natural history of these minor arterial findings on angiography demonstrated a 93% success rate for observation only. The one case that failed was a similar small pseudoaneurysm that continued to increase in size over an observation period of three months and underwent a

successful repair at that time.

One case should not change practice, but it does underscore the need for a period of observation and careful scrutiny of all these extremity injuries despite the lack of hard or soft signs of vascular injury. There will always be exceptions to the standard practice, and we must remain vigilant for those variations in outcome. This approach of a careful peripheral vascular exam only does not even address the issues of the potential for venous injuries as a result of the penetrating wound that may have missed the nearby arterial structures.

### Conflicts of interest

The author(s) declare(s) that there is no conflict of interest regarding the publication of this paper.

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