

Dublex Doppler US Diagnosis and Follow Up of a Post Traumatic Pseudoaneurysm of the Radial Artery

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Abstract: *Introduction:* Post traumatic pseudoaneurysms of the radial artery are rare complications in children. They are seen mostly later; weeks or even months after a penetrating trauma injury. The serious complications of radial artery pseudoaneurysm, such as spontaneous rupture, ischemia and compartment syndrome emerge early diagnosis and treatment. A high index of suspicion is needed for clinicians to avoid confusion with an abscess or hematoma. Duplex ultrasound is the first method to establish the diagnosis of a pseudoaneurysm. It is now widely accepted as the modality of choice for diagnosis of pseudoaneurysm of extremities. Early detection and therapeutic intervention before the pseudoaneurysm manifests clinically with complications is very important. Timely adequate diagnosis and treatment has decrease the morbidity and mortality rates for pseudoaneurysms. As a non invasive method it is now widely used also as a guided therapeutic option before and instead surgical treatment. *Case report:* In this article we present a case of a post traumatic pseudoaneurysm in the radial artery of a 12 years old girl diagnosed by duplex ultrasound. The pseudoaneurysm was detected 2 weeks after a sharp injury caused by a piece of glass at the medial distal part of the right forearm. The pseudoaneurysm was unfortunately first confused as an abscess in gray scale ultrasound. Follow up duplex US for 2 weeks without treatment revealed thrombosed of the pseudoaneurysm continuing with recanalisation of blood flow from radial artery to pseudoaneurysm. *Conclusion:* Imaging with duplex color doppler resolve the diagnosis, otherwise the confusion with an abscess, as in our patient may have the disastrous consequence of incision and drainage. Duplex ultrasound is recommended as an efficiency diagnostic method for forearm and wrist swelling in children after injury. Timely adequate diagnosis and treatment has decrease the morbidity and mortality rates for pseudoaneurysms. This case remind us for careful examination and follow up of the swelling mass after trauma in children. In these cases duplex color Doppler is an imperative investigation to avoid confusion with an abscess or hematoma.

Keywords: Duplex doppler ultrasound, pseudoaneurysm, radial artery, children.

1. Introduction

A pseudo-aneurysm, also known as false aneurysm is a collection of blood leaking from a damage artery, with communication between them. This passage of flow from the originating artery to pseudoaneurysm is called the neck. It is an important key finding for differentiation between a true aneurysm and false aneurysm. The perfused collection wall is composed from surrounding tissue or by the media or adventitia.

Pseudoaneurysms are a rare complication of radial arterial injury especially in children [4]-[21]-[13]. The arterial lesions are not detected usually at the time of injury and present later with pain and swelling at the site of the original injury.

Complications such as thromboembolism, and infection, local compression on neurovascular structures or rupture out to the surrounding tissue emerge the immediate treatment. The poor support of the aneurysm wall is the cause of the rupture. Vascular insufficiency from thromboembolism, is an important clinical sign for early diagnosis and surgical management.

The common causes of radial pseudo aneurysm in children are penetrating trauma and iatrogenic arterial injury [11].

Post traumatic pseudoaneurysms are usually caused from

knife or glass punctures of the artery. Iatrogenic pseudoaneurysms are the result of percutaneous surgical procedures or the use of an artery for injections [10].

Patients with radial artery pseudoaneurysms can present late, in weeks or even months after the injury with pain and swelling of the wrist. The differential diagnoses is with abscess, haematoma, or true aneurysm. Pseudoaneurysms may clinically mistaken with them.

Colour duplex doppler ultrasound is the primary investigation of choice for diagnosis a pseudoaneurysm [10].

2. Case Report

A 12 year-old girl was admitted in our service for ultrasound examination. She had a history of trauma before 2 weeks to her distal medial part of the right forearm. She had an accident with open injury on the antero medial part over the wrist. There was much bleeding at the time of accident and a pressure dressing was applied over the injured area. The parents send the girl immediately to the local city hospital. After removing the pressure dressing there was pulsatile blood at the area of injury. The emergency intervention was performed by a general surgeon who ligated the wound.

Two weeks later she noticed a smooth swelling mass over the ligated area of the injury. A routine gray scale ultrasound

examination was performed at the local hospital. The diagnosis was suspicious for abscess and the girl was referred to the surgeon for incision and drainage. After consultation in our hospital the surgeon referred her again for another expertise ultrasound to our service.

Physical examination before ultrasound showed a soft swelling mass with no palpable thrill cranial to the injury scar. She was afebrile and did not complain for pain, diminished sensation or motor function. The forearm and the hand were well perfused (Fig 1).



Figure 1: Physical examination showed a soft swelling mass with no palpable thrill cranial to the injury scar of right distal forearm

Gray scale ultrasound examination realized in our service with a 12MHz linear probe (US equipment Toshiba 6000) showed the presence of a round hypo-anechoic sacular subcutaneous structure with posterior enhancement, localized cranial to the suture. The lesion was immediately deep to the skin surface not affecting underlying tendons, musculature, or bone. It had measurements 3 x 2.5 cm, with echogenic wall thickness of 3mm.

A turbulent echogenic flow was seen flowing inside from the base of the lesion, resembling of a aneurism (Fig 2).



Figure 2: Gray scale US of the hypo-anechoic lesion with thickened wall and echogenic turbulent content inside

Color doppler ultrasound revealed intrasacular - turnover "red and blue" coming from radial artery. The communicated breach or the tubular neck between the radial artery and the sacular lesion was clearly seen in a length 5mm with flow coming from radial artery to the aneurismal sac (Fig 3).



Figure 3: Color doppler showing turbulent flow inside the sac.

Dublex spectral doppler US showed a - to and - fro spectral waveform: representing flow during sistole and diastole (Fig. 4).

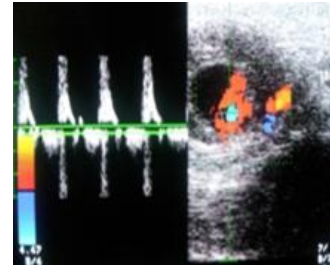


Figure 4: Dublex US showing bidirectional arterial turbulent flow of pseudoaneurism.

The Dublex dopler US findings were all consistent with pseudoaneurism of radial artery.

The patient underwent also a CT with IV angiogram which confirmed the presence of the pseudoaneurism connected with radial artery. She was follow up under close observation, because the parents wanted to send her in a specialized vascular clinic in Germany.

In follow up: after 2 days it was seen echogenic deposition under the wall consistent of clot formation, and less flow was seen in color Doppler inside the pseudoaneurism (Fig 5).

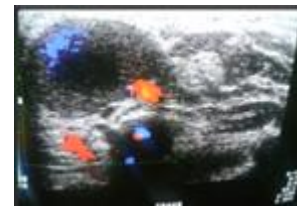


Figure 5: Echogenic deposition under the wall of pseudoaneurism. Reduced blood flow inside on color doppler.

At the third controll after 4 days from dhe second controll: gray scale ultrasoud showed homogene echogenic content representing clotts inside and color doppler showing no flow inside. These findings were consistent of thrombosed pseudoaneurism (Fig 6). The parents were happy with this natural favorable outcome.

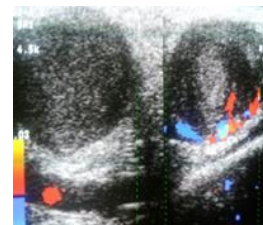


Figure 6: Thrombosed pseudoaneurism after 6 days observation without treatment.

Unfortunately after one week they come again with the girl for follow up. Doppler ultrasound revealed no thrombosis and remarkable flow inside the sac. These findings were consistent of recanalisation of blood flow from radial artery to pseudoaneurism. (Fig7(a),(b).)

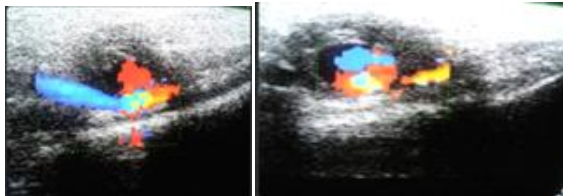


Figure 7: (a),(b). Recanalisation of blood flow from radial artery to pseudoaneurism.

Two weeks follow up without treatment, duplex ultrasound revealed a nonfavorable prognosis of this case of pseudoaneurism. The surgeon in a specialised vascular clinic in Germany performed resection of the pseudoaneurism with restoration of arterial continuity by a venous interposition graft. There was full recovery of the pseudoaneurism without any consequence of vascular perfusion and sensor-motor dysfunction of the patient's right hand.

3. Discussion

Pseudoaneurysm of an artery occurs as the result of a partial or full thickness traumatic wall disruption. As the result of the vessel wall injury the blood escape from the artery to the surrounding tissues. The created hematoma which is pulsatile is gradually surrounded by a fibrous wall capsule. The wall of the pseudoaneurism has no intima layer. Over time the blood can clott gradually within the fibrous wall. The difference of a pseudoaneurism from true aneurism is the composition of the wall. The true aneurysm wall is composed by 3 layers: the intima, media, or adventitia, whereas a false aneurism lack at least the intima.

The most common causes of radial pseudo aneurysm in children and adolescents are penetrating trauma and iatrogenic arterial injuries [11].

The main causes of pseudoaneurisms of extremities are as a consequence of coronary artery catheterization, arteriovenous shunting for dialysis, placement of indwelling catheterization, and arterial puncture for blood gas analysis [10].

The most common cause of jatrogenic pseudoaneurysms in children, is arterial catheterization, and the frequently involved vessel is the femoral artery. Post traumatic artery damage of extremities in children and infants is reported as the consequence venipuncture [6],[19].

Post-traumatic pseudoaneurysms happen rare in the peripheral arteries, especially in upper extremities and is generally a late sequela of artery wall injury. The most common causes of radial pseudo aneurysm in children are penetrating trauma and iatrogenic arterial injuries [13],[1]. The children with penetrating injuries of sharp cuts are more prone to pseudoaneurisms [4].

Many of these lesions are missed at the time of injury. They occur later with unknown mechanism, and present even months to years after the initial injury [20]-[13]-[1]. Post-traumatic pseudoaneurysms happen in every damaged artery after trauma, although femoral and radial arteries are the most common vessels.

There are no statistical data till now to the incidence of pseudoaneurysms in children. This is because of the rarity, and mostly reported as case presentation.

The clinical diagnosis is supported from the history of a trauma and physical examination. Most of post-traumatic pseudoaneurysms are the result of penetrating sharp injuries. The time of presentation, does't correlate exactly with the time of the injury. Sometimes, patients are admitted to hospitals with pseudoaneurysms weeks, months or even years after the trauma [4],[13].

Generally, the patients complain of a pulsatile mass or local swelling as in our case [2]. The history of a previous trauma makes it suspicious for hematoma or an abscess. Erythema, pain or local paresthesia may be other complains [13]. The physician should examine the patient carefully with digital examination, because pulsatility is an important clinical finding suggestive of pseudoaneurism.

Hemorrhage from rupture is the most serious complication with life-threatening consequence. Vascular compromise may lead to ischemia of the surrounding tissues.

Thromboembolism as a potential complicationin, particularly in distal locations of extremities can lead to serious gangrene and amputation of the extremity or finger.

Neurologic symptoms secondary to nerve compression may be other common complications. Pseudoaneurism may undergo also infection. Pseudoaneurisms with possible complications pose special attention for children in the aspect of growth discrepancy secondary to arterial ischemia [13],[16].

US is an accurate diagnostic tool for diagnosis post traumatic pseudoaneurysms. It is an accessible, portable, noninvasive method with high sensitivity and a specificity for detection of pseudoaneurysms. It is the method of choice for evaluation of volar wrist swelling [2].

A pseudoaneurysm in gray-scale US appears as a a hypoechoic cystic structure nearby a supplying artery. Ultrasound is practically used to differentiate between solid and cystic lesions adjacent to the radial artery in the wrist swollen area [15].

Pseudoaneurysms may be single or complex septated sac. Septa and occasionally concentric layers of hematoma may also be seen within the pseudoaneurysm

Grayscale ultrasound can be used to assess some of the features like the size, the number of compartments in the pseudoaneurysm, the length and width of the neck conection to the artery.

However, gray scale US is not diagnostic, since these findings are seen in a number of conditions, and may be confused with other simple or complex cystic lesions like hematomas or abscess [16].

Color Doppler US helps establish the diagnosis. Color Doppler is used in any anechoic-hypoechoic collection sac to

detect or exclude flow inside. A pseudoaneurysm appears as a hypoechoic sac with colour flow present inside. It is seen typically adjacent to the affected artery. Turbulent blood flow is seen by mixed coloring appearance, either red or blue. Duplex Ultrasound is essential to differentiate pseudoaneurysm from non-communicating hematoma [15].

Blood flow within a pseudoaneurysm like in every cystic structure is characterized by a typical swirling motion called the "yin-yang sign". This typical finding of flow may also be seen in saccular aneurysms.

Differential diagnosis is necessary in case of pseudoaneurysm because diagnosis made on this finding alone may not be sufficient and accurate. The key to confirm the diagnosis is visualization of a communicating neck between the sac and the feeding artery. In Duplex Doppler US is seen a typical "to-and-fro" waveform inside [11].

The "to" wave component represents blood entering the pseudoaneurysm during systole; the "fro" wave component represents blood exiting the pseudoaneurysm during diastole. Pulsed Doppler spectral analysis of the radial artery pseudoaneurysm has usually both patterns "yin-yang" and "to-and-fro" waveform. In follow up a spectral waveform analysis of the affected artery is useful for comparison [10]

The adjacent vein should be investigated to exclude the presence of thrombus [10].

The typical findings of pseudoaneurysm in triplex ultrasound are presence of a hypoechoic collection with pulsatility and turbulent flow inside.

Two hallmarks diagnosis of pseudoaneurysm are detection of the neck communication with the injured artery and "to and fro" spectral waveform pattern [10]. Color Doppler shows the characteristic yin-yang sign, whereas pulsed Doppler shows "to and fro" pattern.

Another advantage of duplex US is that it can be performed easily near the bed of the very ill patients, as a guide during thrombin injection or follow up after to ensure a completely pseudoaneurysm [3]-[12]-[8].

In addition, it is very important to analyse the US findings in the clinical context. In our case, the history of previous trauma allowed a more accurate diagnosis of the pseudoaneurysm of radial artery. US examination is also required to access pseudoaneurysm before US guided intervention. Color Doppler US is accurate, noninvasive technique, and easy available.

CT Angiography is very good diagnostic method for pseudoaneurysm, demonstrating a contrast filled sac arising from the donor artery [10]. Three-dimensional CT angiography allows visualization of the lesion from all angles, which is not possible with angiography. It is useful in cases where duplex ultrasound findings are equivocal. The radiation exposure and iodinated contrast agents risk makes it no suitable diagnostic tool particularly for children

Helical CT arteriography has been reported as the initial diagnostic method in most adults patients focal arterial injuries of upper extremities [18].

Conventional Angiography has been the standard method for the diagnosis of pseudoaneurysms in many years. It is important specially for surgeons in treatment planning. The disadvantages of angiography such as invasive nature, radiation and iodinated contrast material, makes it no suitable for children. Management of pseudoaneurysms is not unique. Treatment depends on the size and location of the aneurysm. For very small, stable, and asymptomatic pseudoaneurysms, it is recommended conservative treatment with follow up imaging after to see if spontaneous thrombosis has occurred [10].

The conservative treatment includes clinical observation through watchful waiting and compression bandaging. Both are accessible and practical methods in treating peripheral pseudoaneurysms in children [5].

Observation has been recommended for asymptomatic small pseudoaneurysms of arteries of only minor importance

In recent years, minimal invasive treatment methods using Duplex US have been applied in many cases. These methods included ultrasound-guided compression and percutaneous ultrasound-guided thrombin injection [11].

The positive results of ultrasound-guided injection of thrombin into radial artery pseudoaneurysm has shown this treatment method as a feasible alternative to surgical intervention [8].

These new treatments are not totally safety because of eventually complications such as thrombosis of the affected artery or peripheral vessels in case of thrombin injection. The more sensitive areas, are the head or hand [14].

Despite aforementioned treatment methods, surgical treatment remain standard for children. It includes: resection of the pseudoaneurysm with restoration of arterial continuity by an end-to-end anastomosis and reconstruction using a venous interposition graft as in our case.

Follow up with Duplex US evaluates the anastomotic patency to ensure optimal circulation in the limb, which is during the growth, in the pediatric population [17].

4. Conclusion

Post-traumatic pseudoaneurysm of radial artery is a potentially serious complication in children. A swelling mass in the forearm or wrist in the context of previous injury should raise the suspicious of pseudoaneurysm.

Duplex ultrasound establish a rapid and accurate diagnosis of post traumatic radial artery pseudoaneurysm in children. It is a primary important examination and exclude dangerous consequences of excision in cases of misdiagnosis with an abscess. Early imaging with colour doppler ultrasonography is important for planning the definitive management.

We strongly recommend duplex doppler ultrasound for evaluation of post traumatic mass swelling of extremities in children. Early imaging with duplex colour doppler ultrasound is important for planning the definitive management.

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