Traumatic Lesion of the Brachial Artery in a Pediatric Patient: Treatment With Bioresorbable Vascular Scaffold

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ABSTRACT

PURPOSE: Neurovascular injuries and hand ischemia can occur in up to 20% of cases of supracondylar fractures of the humerus (SCH) in children, and their management is still controversial.

CASE REPORT: We report a case of a brachial artery acute occlusion related to a SCH fracture in a child, successfully treated by endovascular implantation of a bioresorbable vascular scaffold.

CONCLUSIONS: Bioresorbable vascular stent represents an alternative solution in treatment of traumatic children vascular lesions.

KEYWORDS: child, arteries, stents, ischemia, humeral fractures

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Introduction

Supracondylar fractures of the humerus (SCH) are considered the most common fractures of the elbow in children, with annual incidence of approximately 177.3 cases per 100 000.[1] A major risk of SCH is the potential to cause neurovascular injuries, which can lead to hand ischemia and loss of nerve function. In children, the incidence of a pulseless hand after SCH varies from 2% to 20% and up to 21% of these cases have signs of ischemia.[2]

The 2016 Appropriate Use Criteria for the management of pediatric SCH with vascular injury assumed that in case of a SCH presenting with no palpable radial pulse, a qualified clinician may give consideration to reposition the elbow in slight flexion and reassess whether the pulse returns. If the pulse does not restore, a vascular surgery consultation is required.[3]

In the lack of solid clinical data, the management of pulseless pink hand (PPH) remains controversial, and guidelines do not recommend for or against open exploration of the antecubital fossa.[4-6] In children, treatment indirect costs and functional results should be the main goals. Thus, a minimally invasive endovascular approach represents an appealing treatment option, allowing both diagnosis and management of vascular injuries.[7] We report a case of a brachial artery lesion related to a SCH, successfully treated by endovascular implantation of a bioresorbable vascular scaffold (BVS).

Case Report

A 9-year-old girl presented at the Emergency Department for SCH following a distortion of the right arm occurred in horse fall. She was admitted 1 h after the event complaining of severe pain, swelling arm, and numbness of the fingers. At physical examination, the hand was hypothermic and pulses were not palpable. Vascular examination showed good capillary refill but no flow at arterial Doppler ultrasound scan was detected. An X-ray documented a Gartland IIIB fracture (Figure 1).[8] The patient underwent a closed reduction of the fracture and percutaneous pin fixation. At the end of the procedure, the arterial pulses did not reappear. To rule out any vascular injury, arterial Doppler ultrasound was performed demonstrating brachial artery interruption at the fracture level associated with an intramural hematoma; an external hematoma compressing the artery, that could have been drained cutting lacertus fibrosus, was not identified.

With a percutaneous right common femoral arterial approach, digital subtraction angiography (DSA) was performed, showing occlusion of the distal brachial artery, with recanalization of the ulnar and radial arteries immediately below the bifurcation (Figure 2). The occlusion was crossed with two 0.014″ guide wires positioned in the ulnar and radial arteries, respectively, to protect the bifurcation. A 3 × 28 mm BVS (Absorb; Abbott Vascular, Lakeside Drive, Santa Clara, CA) was released in the distal brachial artery (Figure 3), followed by remodeling with a non-compliant 2.5 × 20 mm balloon catheter to solve residual in-stent stenosis (Figure 4). The final angiography confirmed correct positioning and patency of the stent with restoration of distal flow (Figure 5). The stenotic part was interpreted as a spasm of the artery and we decided to not treat it. At the postoperative ultrasound scan, the stenotic part was not detected anymore. A regular sphygmic pulse appeared on radial and ulnar arteries.

Figure 1. Pre-surgical X-rays documented Gartland IIIB fracture of right humerus.

Figure 2. Digital subtraction angiography demonstrated a short occlusion of distal brachial artery with recanalization of the ulnar and radial arteries.

The arm was maintained with a 130° posterior splint for 40 days after surgery, to avoid complete flexion of right arm. After 40 days, cast and pins were removed. The child was submitted to physiotherapy for 3 months after the accident, avoiding rapid movement of the right arm to protect the stent. After hematological consultation, a dual antiplatelet therapy (aspirin

Figure 3. After crossing the lesion with two 0.014″ guide wires, a 3 × 28 mm BVS was deployed.

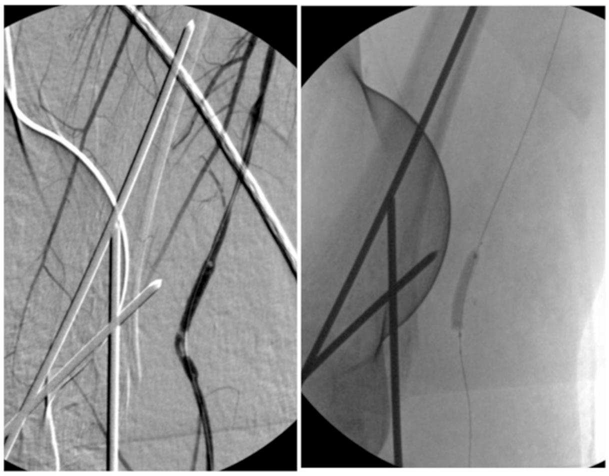

Figure 4. Immediate angiographic control showed correct positioning of the bioresorbable vascular scaffold with residual in-stent stenosis; the stent was dilated with a 2.5 mm catheter balloon.

100 mg/die and clopidogrel 75 mg/die) was administrated for 24 months and a single antiplatelet therapy (only aspirin) for further 12 months. A Doppler ultrasound scan performed 46 months after the procedure showed regular patency of the brachial artery (Figure 6).

Patient and her parents provided written informed consent for information and images to be published as case report.

Discussion

We describe a pediatric case of PPH related to SCH, successfully treated with BVS implantation. To the best of our knowledge, no similar cases have been previously reported.

Figure 5. Final angiographic control showed restoration of the arterial flow.

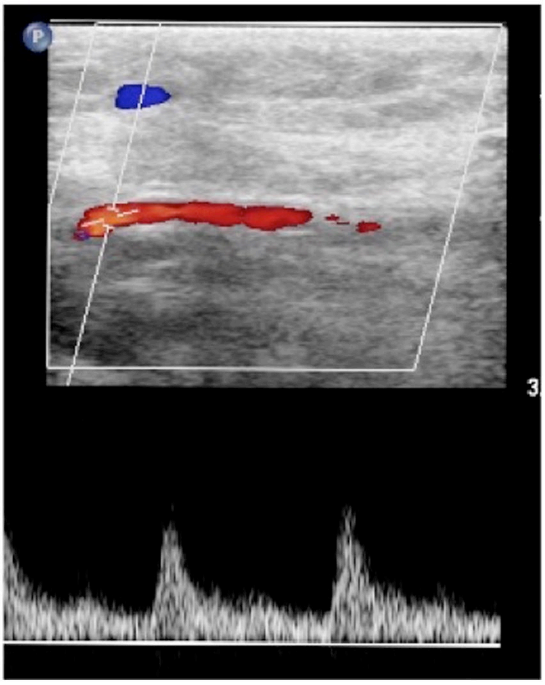

Figure 6. 36 months duplex ultrasound control confirmed the patency of the distal brachial artery.

Vascular damage occurs in 2% to 10% of SCH in children.[11] Although there is no general consensus on their management, angiography should be recommended in persistently pulseless hand after orthopedic fixation.[2-6,10] In fact, over 50% of PPH cases could be related to either vascular entrapment or occlusion due to arterial dissections, as in the presented case.[10]

Usually vascular injures in SCH occur after the initial energy impact and displacement of the fracture, which causes stretching, entrapment, or disruption of neurovascular structure. The brachial artery runs near the skeletal plane, emitting its inferior ulnar collateral branch above the humeral trochlea: the emergence of this branch constitutes a point of fixity for the main trunk making it less mobile and therefore more susceptible to trauma. In those cases, an intramural hematoma occurs and prolonged balloon inflation presents, in our opinion, a higher risk of immediate recoiling. Moreover, in this case, the ultrasound scan did not show an external hematoma compressing the artery that could have been drained.

Traditionally, brachial artery traumatic lesions have been managed surgically, with primary anastomosis, vein or prosthetic grafts, or simple ligation. However, surgery can be associated with complications such as infection, tissue necrosis, and blood loss and may be time-consuming, diverting attention from other management priorities in trauma patients.[11]

Thanks to the evolution in devices and techniques, the endovascular approach has gained worldwide acceptance for the management of traumatic vascular lesions, and angiography has not only a diagnostic role but it is even a therapeutic tool to provide rapid resolution, reducing in-hospital morbidity and mortality.[12]

However, limited data are available describing the use of stents and stent-grafts in traumatic brachial artery injuries.[11,13] Crossing the lesion with the guide wire may be challenging, particularly when dealing with long transections. Moreover, stent-graft deployment may lead to early complications, including distal embolization occurring while crossing the lesion. Durability and long-term patency of the stent-grafts are largely unknown, particularly considering the small diameter of these peripheral vessels.[13] Finally, the presence of a metallic scaffold may limit future surgical access, if needed.

Bioresorbable vascular scaffolds were developed for coronary artery revascularization in the attempt to provide early mechanical support and antiproliferative drug delivery similar to metallic drug-eluting stents, yet overcoming the disadvantages of permanent presence of a metallic structure, by restoring physiologic vasomotion, allowing vascular remodeling and reducing the risks of late thrombosis and jailing of side branches.[14,15]

Among all the available devices, the Absorb BVS has undergone the most extensive evaluation. It is composed by poly-L-lactic acid for 156-mcm-thick stent structure and it has a coating layer containing antiproliferative agent everolimus and polylactide to control drug release. The scaffold is made radio-opaque by the addition of radio-opaque markers on the two ends. The full absorption of the scaffold requires 18 to 24 months by hydrolytic fragmentation.

Unfortunately, despite early favorable results, more recent studies have suggested an increased risk of late failures, fractures, recoiling, and device thrombosis in patients with coronary artery disease.[16] For those reasons, Abbott decided to discontinue Absorb production for lack of safety.

Nowadays, new bioresorbable magnesium scaffold (Magmaris; Biotronik AG, Bülach, Switzerland) could be used. Indeed, the metal scaffolds have practically proven not to fracture during the implantation process, to reabsorb very quickly (about 12 months for magnesium) with less incidence of stent thrombosis and earlier discontinuation of dual antiplatelet therapy (DAPT) with significant advantages for patients at high risk of bleeding. In the future, these stents could be a good option in such cases.

To the best of our knowledge, there have been no cases describing the use of BVS in traumatic arterial occlusions. In the presented pediatric case, considering the young age of the patient, we chose to deploy a BVS to avoid the implantation of a permanent device. Immediate stent recoiling was solved by dilatation. During follow-up, to reduce the risks of stent's fracture and occlusion, the orthopedic surgeons suggested a specific arm support that did not allow arm flexion, and the hematologists administered DAPT for as long as 24 months.

This multidisciplinary approach led not only to the early restoration of arterial flow, through a minimally invasive endovascular approach, but also to the long-term successful vascular restoration, suggesting the potential advantages of BVS in the treatment of post-traumatic vascular occlusions, at least in pediatric patients.

Conclusions

Brachial artery injury represents a relatively rare yet serious complication of pediatric SCH that can be safely managed by endovascular revascularization, thanks to the availability of new devices. In particular, the use of BVS in pediatric vascular injuries is highly appealing, allowing early and permanent flow restoration with no impact on the long-term follow-up. Nonetheless, a multidisciplinary approach (including orthopedic and vascular surgeons, interventional radiologists, hematologists) is essential in a highly specialized trauma center for the adequate management of these delicate clinical situations.

Author Contributions

Conception and design: FT, MF. Data collection: FT, IB, RC, MM. Writing the article: FT, RB, DA, IB, MM, MF. Critical revision: MM, MF, RC, IB. Overall responsibility: FT.

Informed Consent

Patient and her parents provided written informed consent for information and images to be published as case report.

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