European Heart Journal - Case Reports
doi:10.1093/ehjcr/ytaa526

CASE REPORT
Other

Bidirectional endovascular treatment for axillary artery injury secondary to proximal humerus fracture: a case report

Daisuke Kanda [1]*, Itsumi Imagama[2], Yutaka Imoto [2], and Mitsuru Ohishi[1]

[1]Department of Cardiovascular Medicine and Hypertension, Graduate School of Medical and Dental Sciences, Kagoshima University, 8-35-1 Sakuragaoka, Kagoshima City, Kagoshima 890-8520, Japan; and [2]Department of Cardiovascular and Gastroenterological Surgery, Graduate School of Medical and Dental Sciences, Kagoshima University, 8-35-1 Sakuragaoka, Kagoshima City, Kagoshima 890-8520, Japan

Received 29 July 2020; first decision 14 September 2020; accepted 27 November 2020

Background Axillary artery injury secondary to proximal humerus fracture is a rare but serious complication. The management of this injury has traditionally involved surgical treatment.

Case summary A 66-year-old female with gait disturbance slipped and fell off her wheelchair at home. She presented to a local hospital with right shoulder pain and was subsequently urgently transferred to our hospital by helicopter because of suspicion of axillary artery injury. Computed tomography angiography revealed disruption of the right axillary artery. We decided to perform endovascular treatment instead of surgical treatment for axillary artery injury. However, since endovascular treatment via the right femoral artery was impossible, we performed bidirectional (right femoral and right brachial artery approaches) endovascular treatment. We expanded the occluded lesion using a 3.5 mm × 40 mm sized balloon and placed a 5.0 mm × 50 mm stent graft (Gore® Viabahn®) across the lesion. The final subclavian injection confirmed that distal flow to the brachial artery was preserved and that there was no leakage of contrast medium from the axillary artery.

Discussion We performed endovascular treatment for axillary artery injury secondary to proximal humerus fracture. Although surgical repair is typically performed for this kind of injury, our experience suggests that endovascular treatment might be an option in patients with axillary artery injury.

Keywords Proximal humerus fracture • Axillary artery injury • Endovascular treatment • Intravascular ultrasound • Case report

Learning points

- Axillary artery injury secondary to proximal humerus fracture is a rare but serious complication.
- Endovascular treatment might be an option in patients with axillary artery injury.
- Intravascular ultrasonography and a bidirectional approach is useful when performing endovascular treatment.

* Corresponding author. Tel: +81-99-275-5318, Fax: +81-99-265-8447, Email: kanchan@m3.kufm.kagoshima-u.ac.jp
Handling Editor: Marco De Carlo
Peer-reviewers: Riccardo Liga and Ali Nazmi Calik, Arif Anis Khan
Compliance Editor: Reshma Amin
Supplementary Material Editor: Aiste Monika Jakstaite

Introduction

Proximal humerus fractures account for 4–6% of all fractures.[1] Axillary artery injury associated with proximal humerus fracture, although rare,[2–4] is a serious complication of such a fracture, and can cause upper limb ischaemia and/or bleeding.[5] The management of this injury has traditionally involved surgical treatment. Herein, we report a case of axillary artery injury secondary to proximal humerus fracture that was repaired by endovascular treatment instead of operative treatment.

Timeline

Time	Clinical presentation and treatment
16th June, 11:00 am	66-year-old female, proximal humerus fracture, axillary artery injury suspected.
16th June, 4:00 pm	Patient transferred to our hospital. Computed tomography angiography showed occlusion of the axillary artery, for which endovascular treatment was performed.
Day 1 of admission	Computed tomography angiography showed good patency of the right axillary artery.
Day 24 of admission	Patient discharged in a stable condition.
12 months after discharge	Follow-up indicated no complications.

Case presentation

A 66-year-old female with gait disturbance slipped and fell off her wheelchair at home. She was right-handed and needed a wheelchair in everyday life due to leg weakness of unknown origin. She did not take any medications. She presented to the orthopaedic department of a local hospital complaining of right shoulder pain. Physical examination revealed marked swelling around the right shoulder joint. Additionally, pulsations of the right radial and ulnar arteries were weak but palpable. She also had radial nerve palsy; however, this paralysis gradually ameliorated during physical examination. Right shoulder radiograph showed a proximal humerus fracture with medial displacement of the humeral shaft (*Figure 1A*), for which closed reduction was attempted under intravenous anaesthesia. Although the humeral shaft displacement was improved after the attempt (*Figure 1B*), radial and ulnar pulsations were no longer palpable. Therefore, she urgently transferred to our hospital by helicopter. At the time of arrival, her vital signs were stable. Laboratory tests showed the abnormal values in C-reactive protein levels (6.7 mg/L, reference range <1.4 mg/L), creatinine phosphokinase levels (291 IU/L, reference range 41–153 IU/L), and extended activated partial thromboplastin time (41.7 s, reference range 24.0–39.0 s). Haemoglobin (12.3 g/L, reference range 11.6–14.8 g/L), creatinine (0.67 mg/dL, reference range 0.46–0.79 mg/dL), platelets (262×10^9/L, reference range 158–348×10^9/L), prothrombin time (12.8 s, reference range 10.7–12.9 s), and fibrinogen (400 mg/dL, reference range 200–400 mg/dL) were within reference range. Computed tomography (CT) angiography revealed disruption of the right axillary artery (*Figure 2A*) along with contrast medium extravasation and a large haematoma (*Figure 2B*). Emergency angiography via the right common femoral artery was attempted to confirm the site of injury of the axillary artery after intravenous administration of heparin. However, the prominent meandering of the abdominal aorta and brachiocephalic artery hindered manipulation of the various catheters. Finally, right subclavian angiography was performed using a 4-Fr internal mammary artery catheter, which revealed disruption of the axillary artery distal to the origin of the subscapular artery (*Figure 2C*) and presence of a collateral artery supplying blood to the right brachial artery (*Figure 2D*, Supplementary material online, *Video S1*). In consultation with vascular surgeons, we decided to attempt performing endovascular treatment via the right femoral artery; however, it was impossible due to the pronounced meandering of the abdominal aorta and brachiocephalic artery. Therefore, we attempted to puncture the pulseless right brachial artery under ultrasound guidance, but we were unsuccessful. Fortunately, we were able to cross the breach in the axillary artery using a 0.014-inch guidewire (Cruise®, ASAHI INTECC, Japan) supported by a microcatheter through the 4-Fr internal mammary artery catheter via right femoral artery (*Figure 3A*, Supplementary material online, *Video S2*), and subsequent contrast injection via the microcatheter showed flow in the right brachial artery (*Figure 3B*). We subsequently successfully punctured the right brachial artery using the guidewire inserted into the right brachial artery across the disrupted axillary artery as a marker (Figure 3C, Supplementary material online, *Video S3*). Then, a 6-Fr sheath was inserted into the right brachial artery, and the guidewire which was advanced via right femoral artery was extracted through the 6-Fr sheath in the right brachial artery using a snare catheter (*Figure 3D*, Supplementary material online, *Video S4*). Next, the site of thrombotic occlusion of the axillary artery was observed using an intravascular ultrasound probe (AltaView®, Terumo, Japan) inserted via the brachial artery (*Figure 4*), which demonstrated thrombosis and dissection of the axillary artery (*Figure 4B–D*) and the vessel diameter ranges from 4.5- to 5.0-mm at the occluded lesion and proximal normal axillary artery. We expanded the occluded lesion using a 3.5 mm × 40 mm sized balloon and placed a 5.0 mm × 50 mm Viabahn stent graft (Gore, Flagstaff, AZ, USA) across the lesion via a brachial artery (*Figure 5A*). Furthermore, the stent graft was dilated with a 5.0 mm × 40 mm sized balloon. The final subclavian injection ensured that distal flow to the brachial artery was preserved and that there was no leakage of contrast medium from the axillary artery (*Figure 5B*, Supplementary material online, *Video S5*). Intravascular ultrasonography images revealed adequate expansion of the stent graft (*Figure 5D*). After the procedures, the right brachial, radial, and ulnar arteries were well palpable. Computed tomography angiography performed the day after the procedure showed good patency and no dye leakage from the right axillary artery. The patient received dual antiplatelet therapy with aspirin and clopidogrel after the procedure. The shoulder replacement surgery was needed and scheduled, and the patient was then discharged 24 days after the procedure. At 12 months after

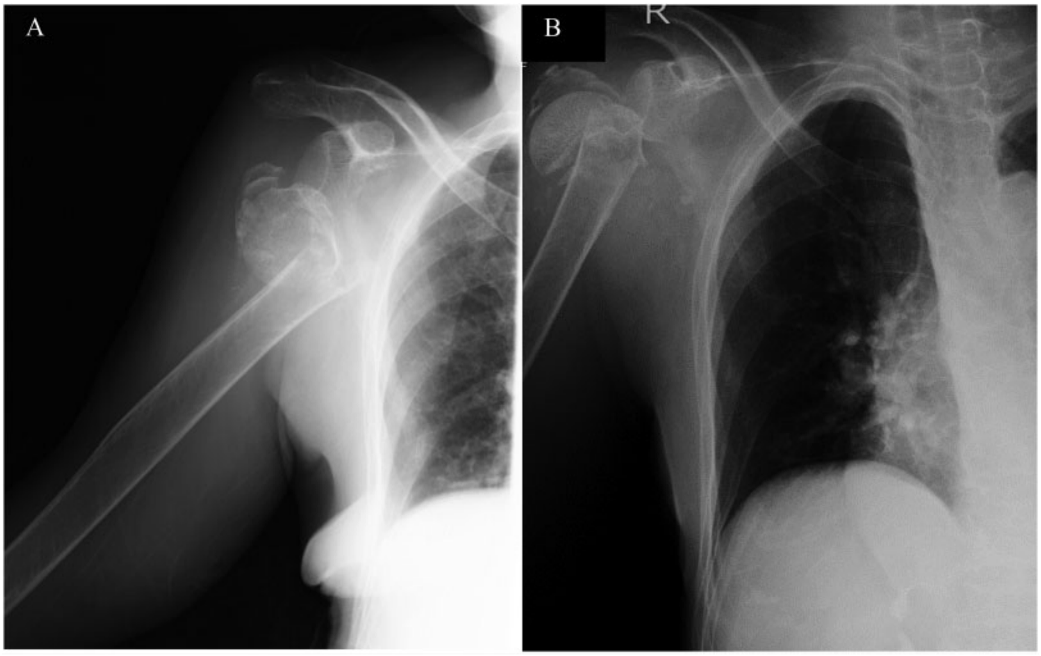

Figure 1 Right shoulder radiograph before (*A*) and after (*B*) closed reduction.

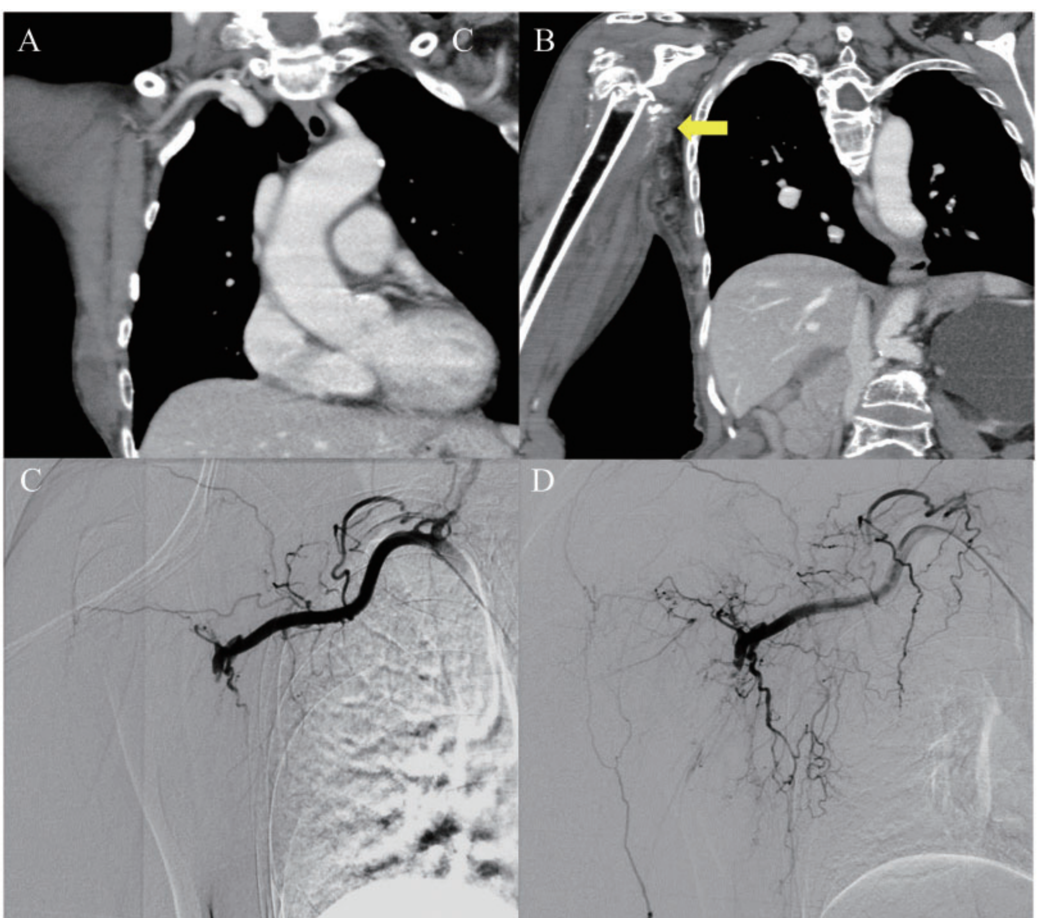

Figure 2 Computed tomography angiography showing disruption of the right axillary artery (*A*) and contrast medium extravasation from the right axillary artery (*B*). Right subclavian angiogram showing occlusion of the right axillary artery (*C*) and contrast-enhanced visualization of the right brachial artery via collateral flow (*D*).

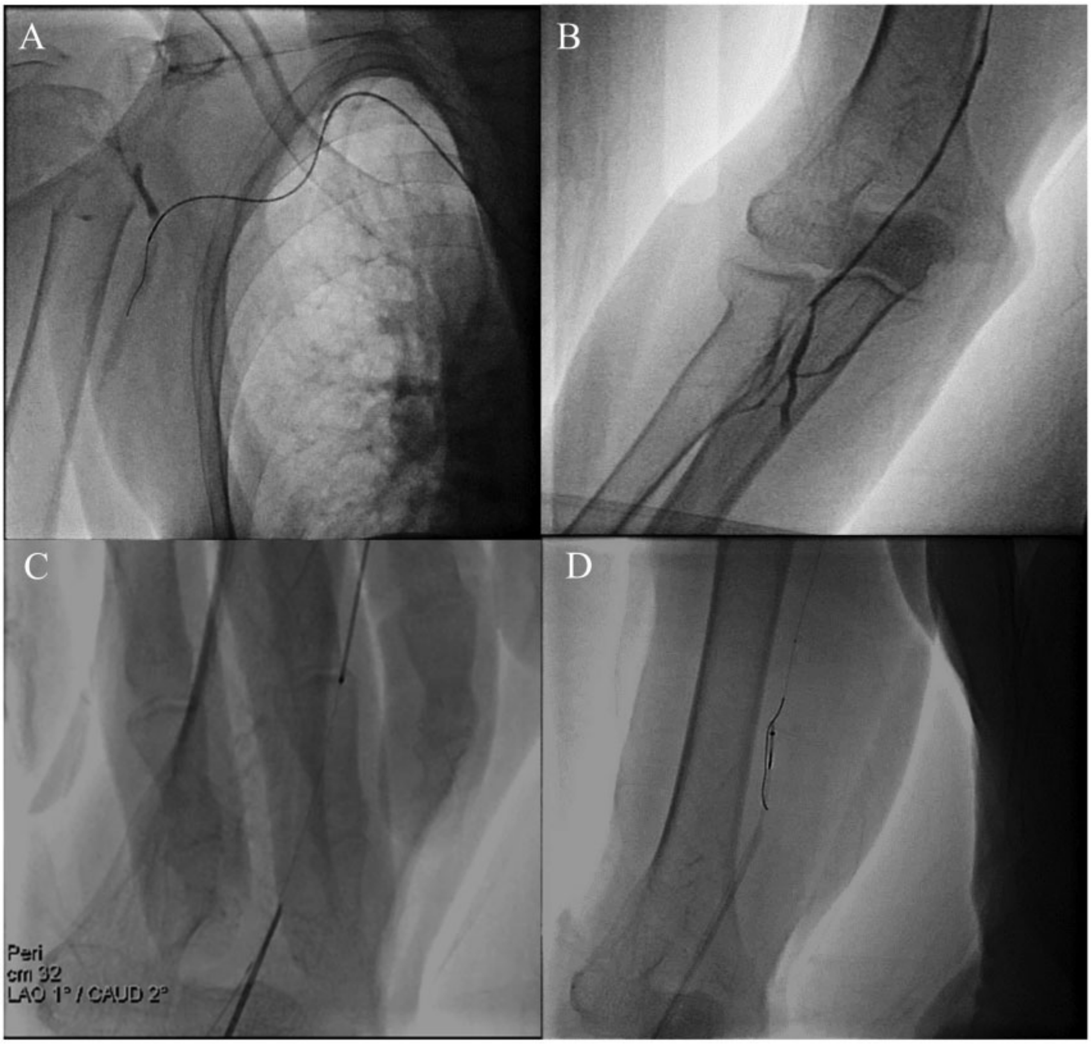

Figure 3 Procedures for obtaining right brachial artery access. The guidewire was advanced into the right brachial artery (*A*). Injection via the microcatheter demonstrated the flow of the right brachial artery (*B*). Puncture of the right brachial artery using the guidewire as a marker (*C*). Extraction of the guidewire using a snare catheter (*D*).

discharge, the patient had no neurological symptoms, and the radial and ulnar arteries were well palpable. There were no abnormal findings suspecting restenosis or occlusion of the axillary artery.

Discussion

Axillary artery injury associated with proximal humerus fracture is a rare but serious complication of such injury.[6] Surgical repair is the standard treatment for the vascular injury at this site. However, we were able to repair axillary artery injury without any complications using endovascular treatment via a bidirectional approach. Furthermore, we could confirm the thrombosis and dissection of the axillary artery by intravascular ultrasonography during the procedure.

Axillary artery injury secondary to proximal humerus fracture tends to involve the third part of the axillary artery. This part of the artery, which includes the segment distal to the pectoralis minor tendon, has three branches (anterior and posterior circumflex humeral arteries and subscapular artery), resulting in limitation of its mobility. This increases its susceptibility to injury[7] with fractures causing medial displacement of the humerus shaft, which induces kinking, shearing, or compression of the axillary artery. This mechanism might lead to intimal tears, resulting in thrombosis and occlusion of the artery. Furthermore, decreased arterial elasticity in older patients might increase their risk of vascular injury.[8] The most common physical sign of axillary artery injury associated with proximal humerus fracture is an absent or diminished radial pulse. A previous report demonstrated that 92% of patients with axillary artery injury had abnormal distal pulses.[9] Therefore, axillary artery injury should be strongly suspected in older patients with medial displacement of the humerus shaft and abnormality of the radial pulse, as in our case. In previous case reports, axillary artery injury in patients with humerus fracture or glenohumeral dislocation was confirmed by CT angiography.[10,11] We also performed CT angiography and confirmed the injury of the third

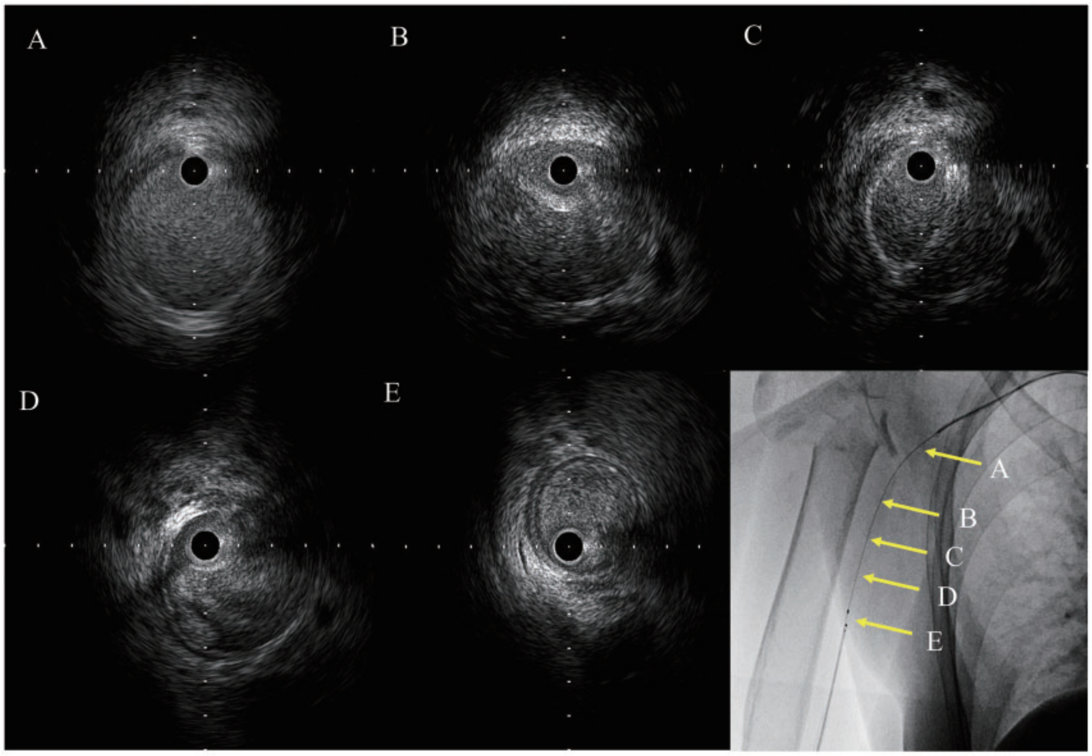

Figure 4 Evaluation of the right axillary artery using intravascular ultrasonography. Proximal normal site (*A*), injured site with dissection and thrombosis (*B–D*), and normal brachial artery (*E*).

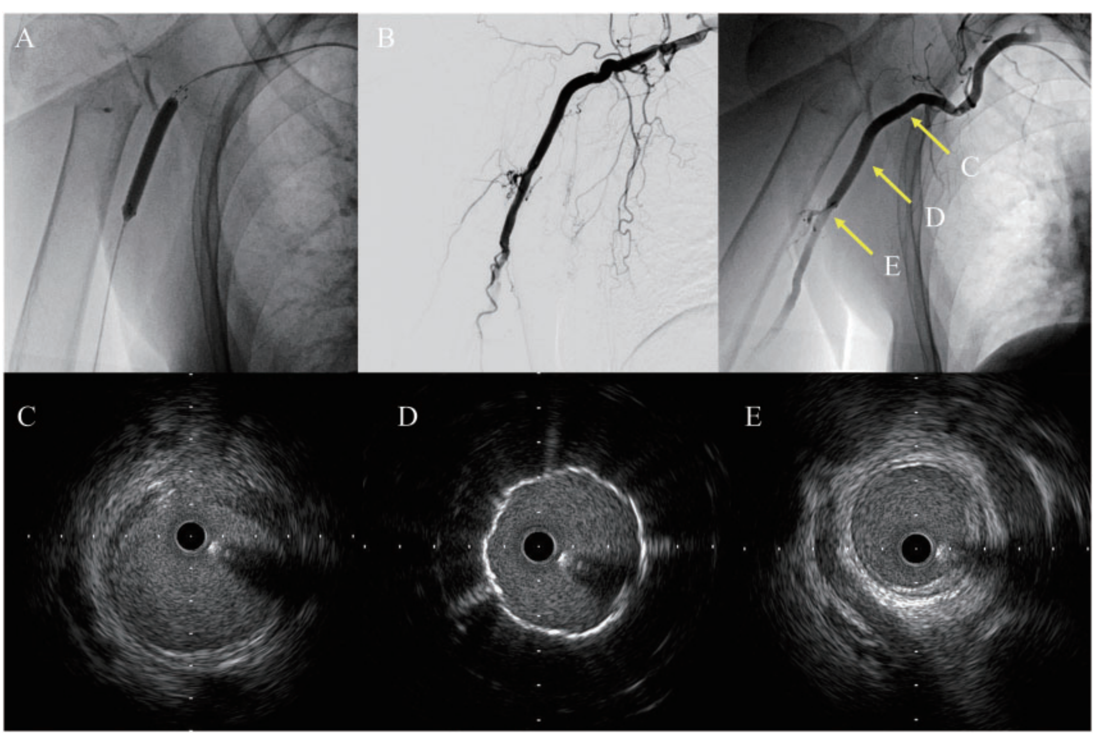

Figure 5 Stent graft placement (*A*) and subclavian injection after graft placement (*B*). Intravascular ultrasonography images of the normal axillary artery (*C*), stent graft implanted lesion (*D*), and normal brachial artery (*E*).

part of the axillary artery. Our experience and the previous reports highlight the importance of performing CT angiography in patients with suspected axillary artery injury.

Axillary artery injury secondary to proximal humerus fracture is reportedly associated with increased duration of hospitalization and mortality during admission,[6] and traditionally requires surgical treatment. However, surgical treatment is challenging due to the confined anatomical space, high density of important neurovascular structures in the region, and the overlying skeletal cage of the thoracic apex.[12] Furthermore, surgical repair of vascular injury in the trauma setting is also often complicated by associated venous injuries, soft tissue injury, and haematoma formation. Recently, endovascular techniques have been safely utilized in the treatment of patients with vascular injuries at various sites.[13,14] A few case reports demonstrated endovascular treatment using stent grafts for axillary artery injuries in patients with humerus fractures[11] and glenohumeral dislocation.[10] In our case, endovascular treatment of the axillary artery injury via only the right femoral artery approach was impossible. Therefore, we performed the endovascular repair using both the right femoral and right brachial approaches. Although a few techniques were needed to puncture the right brachial artery, we completed the procedure without any complications. Endovascular treatment might also help to avoid the risk of general anaesthesia. Furthermore, intravascular ultrasound evaluation was performed in this case, which enabled detection of the arterial dissection and thrombosis that caused axillary artery occlusion. Hence, this device might provide useful insight when performing endovascular treatment.

In this case, we successfully performed endovascular treatment with a stent graft instead of operative treatment; however, there are the risks of restenosis or occlusion of the stent graft during follow-up. In deciding the treatment for vascular injury, it is important to carefully consider the advantages and disadvantages of both treatments (Supplementary material online, *Table S1*) in each case.

Conclusion

We performed endovascular treatment for axillary artery injury secondary to a proximal humerus fracture. Although management of this injury typically involves the surgical treatment, endovascular treatment might be an option in patients with axillary artery injury.

Lead author biography

Daisuke Kanda is an assistant professor in Department of Cardiovascular Medicine and Hypertension, Graduate School of Medical and Dental Sciences, Kagoshima University, Japan. He was born in Nagasaki in 1976. He graduated from the faculty of Medicine, Kagoshima University in 2001. He is an interventional cardiologist and is feeling that working to help patients is greatly rewarding.

Supplementary material

Supplementary material is available at *European Heart Journal – Case Reports* online.

Acknowledgements

We thank the staff of the Department of Cardiovascular Medicine and Hypertension for their assistance with the data processing.

Slide sets: A fully edited slide set detailing this case and suitable for local presentation is available online as Supplementary data.

Consent: The authors confirm that written consent for submission and publication of this case report, including the accompanying images and associated text, was obtained from the patient in line with COPE guidance.

Conflict of interest: none declared.

Funding: none declared.

References

1. Lanting B, MacDermid J, Drosdowech D, Faber KJ. Proximal humeral fractures: a systematic review of treatment modalities. *J Shoulder Elbow Surg* 2008;**17**:42–54.
2. Menendez ME, Ring D, Heng M. Proximal humerus fracture with injury to the axillary artery: a population-based study. *Injury* 2015;**46**:1367–1371.
3. McLaughlin JA, Light R, Lustrin I. Axillary artery injury as a complication of proximal humerus fractures. *J. Shoulder Elbow Surg* 1998;**7**:292–294.
4. Zhang Q, Wang S, Tang C, Chen W, Zhang Y, Chen L. Axillary artery lesions from humeral neck fracture: a study in relation to repair. *Ther Med* 2013;**5**: 328–332.
5. Demetriades D, Asensio JA. Subclavian and axillary vascular injuries. *Surg Clin North Am* 2001;**81**:1357–1373.
6. Karita Y, Kimura Y, Sasaki S, Nitobe T, Tsuda E, Ishibashi Y. Axillary artery and brachial plexus injury secondary to proximal humeral fractures: a report of 2 cases. *Int J Surg Case Rep* 2018;**50**:106–110.
7. Milton GW. The circumflex nerve and dislocation of the shoulder. *Br J Phys Med* 1954;**17**:136–138.
8. Kelley SP, Hinsche AF, Hossain JFM. Axillary artery transection following anterior shoulder dislocation: classical presentation and current concepts. *Injury* 2004;**35**: 1128–1132.
9. Hasan SA, Cordell CL, Rauls RB, Eidt JF. Brachial artery injury with a proximal humerus fracture in a 10-year-old girl. *Am J Orthop* 2009;**38**:462–466.
10. Elkbuli A, Ehrhardt J Jr, McKenney M, Boneva D, Martindale S. Axillo-subclavian dissection and pseudoaneurysm following inferior glenohumeral dislocation: case report and literature review. *Int J Surg Case Rep* 2020;**66**:130–135.
11. Kumar RM, Reddy SS, Sharma R, Mahajan R, Talwar KK. Endovascular repair of a traumatic axillary artery pseudoaneurysm. *Cardiovasc Intervent Radiol* 2009;**32**: 598–600.
12. Branco BC, Boutrous ML, DuBose JJ, Leake SS, Charlton-Ouw K, Rhee P *et al.* Outcome comparison between open and endovascular management of axillo-subclavian arterial injuries. *J Vasc Surg* 2016;**63**:702–709.
13. Elkbuli A, Shaikh S, McKenney M, Boneva D. Successful management with endovascular stent graft repair following gunshot wound to the subclavian artery: case report and literature review. *Int J Surg Case Rep* 2019;**64**:75–79.
14. De Backer O, Arnous S, Sandholt B, Brooks M, Biasco L, Franzen O *et al.* Safety and efficacy of using the Viabahn endoprosthesis for percutaneous treatment of vascular access complications after transfemoral aortic valve implantation. *Am J Cardiol* 2015;**115**:1123–1129.