Early Stent Graft Perforation after Endovascular Repair for Pseudoaneurysm That Was Associated with Clavicle Nonunion

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We report the case of a 62-year-old man who experienced a left axillary artery pseudoaneurysm that was secondary to nonunion of a 30-year-old left midshaft clavicle fracture. He initially underwent endovascular repair using a self-expanding nitinol stent graft, which was perforated at postoperative day 5. Therefore, we performed open repair with concomitant clavicle resection, and no complications were observed during an approximately 6-year follow-up. We recommend performing clavicle resection with vascular repair to prevent recurrence in similar cases.

**Keywords:** axillary artery pseudoaneurysm, clavicle nonunion, early stent graft perforation

**Introduction**

Clavicle fracture is a common shoulder injury, although the incidence of related vascular complications is only 0.4%.1 We present a case of a pseudoaneurysm that was secondary to nonunion of a 30-year-old clavicle fracture. The patient initially underwent endovascular treatment (EVT), although he subsequently experienced early stent graft perforation and ultimately underwent open repair.

**Case Report**

A 62-year-old man was admitted to our hospital due to sudden severe pain with pulsatile swelling under the left clavicle. Computed tomography (CT) revealed nonunion of a 30-year-old left midshaft clavicle fracture after improper fixation using a wire (Fig. 1A). The patient also reported experiencing paresthesia around his left shoulder at approximately 1 month before his admission. Enhanced CT revealed a pseudoaneurysm that originated from the first segment of the left axillary artery at the first rib (Fig. 1B). Based on these findings, the patient underwent EVT using a self-expanding Fluency Plus stent graft (10 mm × 40 mm). He reported that the pain resolved immediately and the abnormal pulsation disappeared. Therefore, he was discharged at postoperative day 5, and was cautioned to avoid abduction movement (>90°) of his left upper limb.

However, the same pain and abnormal pulsation returned on the night after his discharge. He was re-admitted to our hospital and underwent CT and angiography, which revealed a recurrent pseudoaneurysm due to stent graft perforation (Fig. 2A–2C). Both the covering graft material and the stent structure were compromised, and the stent was dilated and perforated at the midpoint (type III endoleak), although no type I or type II endoleaks were observed. Therefore, two balloon catheters were placed proximal and distal to the perforation, and were inflated to control the pressure in the pseudoaneurysm.

The patient was then transferred to the operating theater for resection of the pseudoaneurysm. A diagonal skin incision was made across his clavicle (from the upper proximal side to the lower distal side), and we resected a part of the clavicle that was proximal to the nonunion. We also attempted to dissect the proximal and distal axillary arteries outside the pseudoaneurysm. However, severe adhesion made the dissection difficult, and although we secured the distal axillary artery, we could not secure the proximal axillary artery. There was a risk of brachial plexus injury if we performed further dissection, and we elected to open the pseudoaneurysm. We controlled the bleeding from the perforation digitally, placed a proximal vascular clamp (as well as a distal clamp after dissecting the vessel), and removed the stent graft. Next, we replaced the injured vessel with a 10-mm woven double velour tube...
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graft, and resected the distal part of the clavicle (with the wire) to avoid future recurrence. No complications were observed during the approximately 6-year follow-up.

Discussion

In diseases or injuries that involve the subclavian or axillary vessels, EVT is an attractive treatment option, because it provides easy and non-invasive access, which is associated with a shorter operative time in properly selected cases.2,3 The present case confirms that association, as the EVT provided rapid resolution of the patient’s symptoms in an emergent setting (without the risk of brachial plexus injury during open repair). However, EVT can also result in stent deformity or fracture,4–6 and this complication may be related to several factors. The first factor is compression of the stent by the surrounding structures, especially the clavicle and first rib, as in the present case. In this context, Meier et al. have reported that first rib resection is a potential preventative treatment, although this theory has not been confirmed.5 The second factor is frequent vessel mobility that is caused by upper limb movement, as frequent flexion and extension can cause stent fatigue and fracture. Although self-expanding stents are expected to be more resistant to external forces (vs. stainless steel stents),5 they are still prone to fracture, with reported fracture intervals of 4 months to 2 years.4,6 However, the stent graft perforation and fracture in the present case occurred at postoperative day 5, and the injuries occurred at almost the same site in the axillary artery (before and after stent graft placement). Therefore, we speculate that the cause was not a fatigue fracture in the stent, and that the injury was related to the clavicle nonunion or the 30-year-old wire that had remained in situ. In this context, the relative anatomical locations of the vessel and nonunion or wire might have gradually changed and come into contact with each other. Thus, we believe that clavicle resection (including the nonunion and fixing wire) should be performed without delay after EVT in similar cases, as clavicle resection does not increase the operative risk because dissection of the neurovascular bundle is unnecessary. Therefore, we agree with a previous case report that emphasized the necessity of a clavicle-related intervention (either excision or fixation) to prevent potential recurrence.1

Fig. 1 Computed tomography at admission. (A) Nonunion of the left midshaft clavicle fracture. (B) The pseudoaneurysm originates from the axillary artery at the first rib. A 30-year-old wire that was used to fix the clavicle fracture is also visible.

Fig. 2 The stent fracture. (A) Computed tomography reveals the recurrent pseudoaneurysm, which was stained darker (vs. at admission). (B) Three-dimensional computed tomography reveals that the stent graft was dilated and injured at its midpoint. (C) Digital subtraction angiography reveals a jet at the perforation.
Several case reports have described pseudoaneurysm formation that was associated with nonunion or delayed union of the clavicle.\textsuperscript{1,7,8} However, our case is unique, as the clavicle nonunion had been asymptomatic for 30 years before the vascular complication, and this type of case has never been reported.

In summary, we believe that EVT with clavicle resection may be the best treatment for similar emergent cases, due to these procedure’s prompt effect and noninvasive nature. Nevertheless, even if successful management is achieved using this method, it is important to consider the risk of potential stent graft failure after EVT in the clavicular region.

**Conclusion**

We experienced a case of axillary artery pseudoaneurysm that was secondary to clavicle nonunion. The patient was initially treated via EVT, although stent graft perforation occurred at postoperative day 5; we successfully treated the patient using open repair and clavicle resection. Therefore, we believe that concomitant clavicle resection and vascular repair (using endovascular or open techniques) are appropriate in similar cases.

**Disclosure Statement**

The authors have no conflicts of interest to declare.

**Author Contributions**

Study conception: HN. Data collection: HN. Analysis: HN, NO, and MT. Writing: HN. Critical review and revision: all authors. Final approval of the article: all authors. Accountability for all aspects of the work: all authors.

**References**


