Balloon rupture with eversion during innominate vein angioplasty requiring surgical retrieval

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ABSTRACT

Balloon rupture during angioplasty can with calcified or recalcitrant lesions. A 61-year-old woman presented with worsening arm and facial swelling. She had a history of left upper extremity thrombolysis and stenting of the innominate vein 6 years prior. Venography showed severe in-stent stenosis. After crossing the lesion, a 12-mm balloon was inflated, which ruptured at nominal pressure. The balloon became stuck and could not be moved over the wire even after retraction of the sheath. A limited surgical cutdown was performed, and the balloon and the wire were removed together. The ruptured balloon part was found to be everted and circumferentially wrapped around the wire, preventing the wire exchange. After cutting the everted portion of the balloon, the catheter was removed without losing wire access. A high-pressure balloon was subsequently used to treat the lesion successfully. Her symptoms had resolved on follow-up, and the stent remained patent after 6 months. (J Vasc Surg Cases Innov Tech 2023;9:101242.)

Keywords: Angioplasty; Balloon rupture; Innominate vein

Balloon angioplasty is a common endovascular procedure for venous and arterial occlusive disease. Balloon rupture has a reported incidence of 3.6% to 10%.[1] With increasing advances in the manufacture of balloons, the incidence of balloon rupture has declined. Balloon rupture can lead to vessel injury and possible balloon fragmentation and embolization.[2] Therefore, maintaining guidewire access across the lesion is crucial to manage complications related to balloon rupture. Endovascular retrieval of retained balloon fragments is an appropriate strategy but requires experience with different techniques. However, open surgical removal will sometimes be necessary to prevent further complications.[3] The lesion morphology characteristics have a role in determining the likelihood of procedural success and the risk of procedural complications such as balloon or vessel rupture.[4] Gradual inflation of the balloon, serial upsizing, and avoidance of inflation above the rated burst pressures are suggested strategies to avoid procedural complications.[5]

In the present report, we describe the case of circumferential angioplasty balloon rupture with eversion and wrapping around the guidewire in a patient treated for in-stent stenosis of the left innominate vein. The balloon was retrieved after surgical cutdown without losing wire access. The patient recovered well with symptomatic relief and stent patency for ≤7 months. The patient provided written informed consent for the report of her case details and imaging studies.

CASE REPORT

A 61-year-old female patient, who was morbidly obese (body mass index, 58 kg/m^2) and hypertensive and had Crohn's disease, presented with recurrent left upper extremity and facial swelling. Six years prior, she had developed left upper extremity deep vein thrombosis and was treated with EKOS (Boston Scientific) catheter-directed thrombolysis, followed by stenting of the left innominate vein with two E-Luminexx stents (BD). She was discharged with prescriptions for warfarin and enoxaparin. She had no history of central venous catheter insertion preceding the event. Also, as part of her follow-up, she underwent computed tomography in neutral and extension positions to rule out thoracic outlet syndrome. Within 6 months, she had developed recurrent symptoms and occlusion of the stents and underwent recanalization and balloon angioplasty.

She remained asymptomatic for several years, with a recurrence of symptoms 6 years after her initial procedure. Her workup, including computed tomography angiography of the chest and duplex ultrasound, was inconclusive regarding the patency of the stent. Because of her worsening symptoms, the decision was made to proceed with intervention.

After access through the left basilic vein with a 7F sheath, venography showed severe focal in-stent restenosis (Fig 1, *A*). After crossing the lesion, a 12 × 80-mm Mustang balloon (Boston Scientific) was inflated across the lesion, which ruptured at 10 atm (nominal pressure) after displaying a severe waist that

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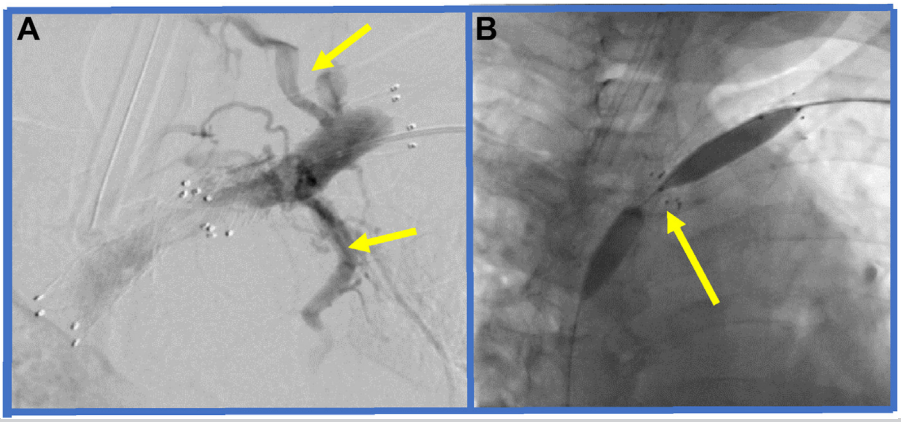

Fig 1. A, In-stent stenosis with collateral vessels (*arrows*) around a severe lesion. **B,** Balloon angioplasty with severe, recalcitrant stenosis (*arrow*).

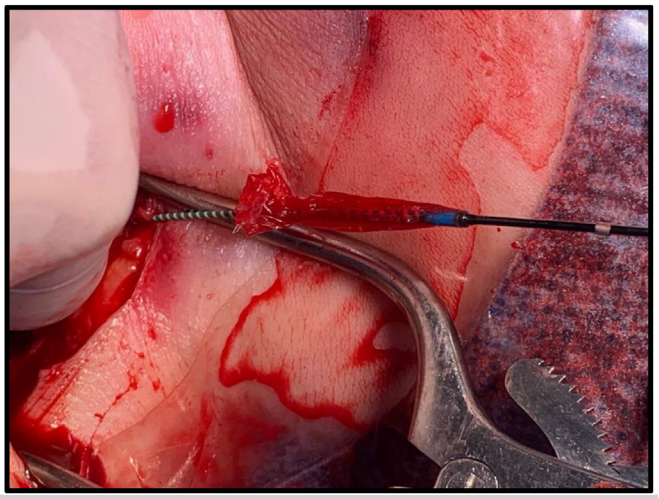

Fig 2. Intraoperative photograph showing eversion and wrapping of the ruptured balloon around the wire.

did not respond to treatment (Fig 1, *B*). The balloon was retracted into the sheath, and then severe resistance was encountered. The sheath was upsized to 8F to retrieve the balloon. At that point, a radiograph was taken, which confirmed that the balloon had become lodged at the entry point in a mid-arm position and could not be moved further over the wire, even after retraction of the sheath. The wire (which remained in the stent at this point) and the balloon catheter were pulled back but could not be removed from the vein. A small surgical cut-down 2 cm above the cubital fossa was performed after administration of local anesthesia, and the balloon with the wire were retracted en bloc. The ruptured portion of the balloon was found to be everted and circumferentially wrapped around the wire (Fig 2), and difficulty was encountered in attempting to remove the wire from the balloon. After cutting the everted portion of the balloon, the catheter was removed without losing wire access intraluminally but outside the stent (Fig 3). The procedure was completed with vessel loop control around the vein by angioplasty using a 10 × 40-mm Athletis high-pressure balloon (Boston Scientific) and a 14 × 40-mm Atlas balloon (Bard Medical). The completion venogram showed excellent flow with resolution of the collateral vessels (Fig 4). The basilic vein was repaired using 6-0 Prolene suture.

She was discharged with apixaban and aspirin. Her symptoms resolved, and the stent appeared patent at 7 months.

DISCUSSION

Since the inception of peripheral endovascular interventions when Grüntzig performed the first femoral artery balloon angioplasty in early 1970, several advances have been made in peripheral vascular interventions.[6] The incidence of balloon rupture has decreased with advances in balloon manufacturing and refinement of the technology. Balloon rupture has a reported incidence of 3.6% to 10%.[1] However, in a more recent report, Vesely and Pilgram[7] reported a 1.9% incidence of rupture, with one balloon bursting at 24 atm of pressure and another at 26 atm during the management of hemodialysis-related central stenosis.

The risk factors for balloon rupture include oversizing, calcification, and in-stent stenosis.[8] However, in some cases, the operator must inflate the balloon to greater than the rated burst pressure in resistant lesions. Alternatively, noncompliant high-pressure balloons can be of use to overcome such lesions. In the present case, balloon rupture occurred close to the nominal pressure. The subsequent use of a high-pressure balloon, although relatively undersized, seemed to "break" the resistant lesion and allow for subsequent dilatation to a larger size. The 10-mm balloon was the largest high-pressure balloon available in the operating room at the time of the procedure. An alternative approach is the gradual upsizing concept; however, it is unclear whether that would have avoided rupture at a larger size. Balloon rupture, per se, is not a complication but can be associated with perforation, dissection, and/or technical problems with retrieval of the ruptured balloon, such as occurred with our patient.[9]

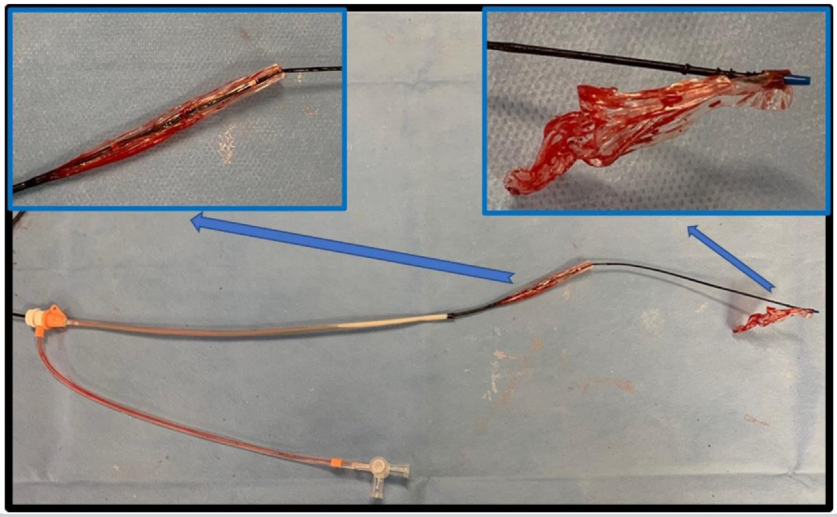

Fig 3. A, Circumferential balloon rupture and eversion. The distal portion of the ruptured balloon was everted and wrapped around the wire (**Left Insert**). After cutting the distal portion (**Right Insert**), the balloon catheter was released from the wire and retrieved.

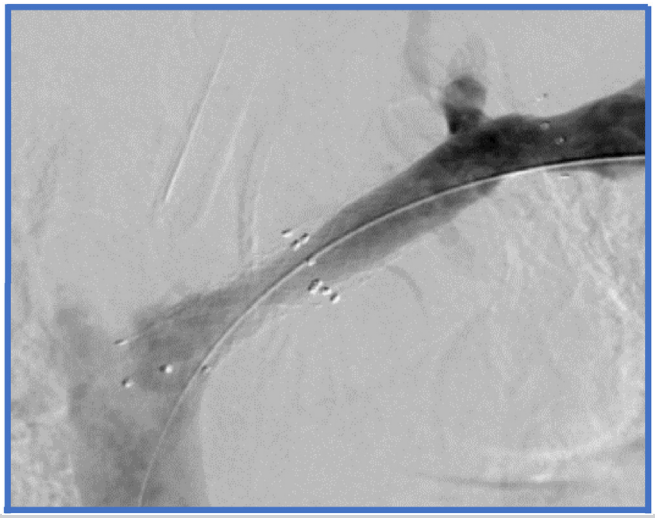

Fig 4. Final venogram showing a patent stent with no residual stenosis.

Balloon rupture can occur in form of pinhole, longitudinal, or circumferential tears. The balloon is designed to rupture in a longitudinal orientation. Balloons with pinhole or longitudinal tears are retrieved easily as one part, and the force used for withdrawal will not lead to detachment. In contrast, for balloons with circumferential tears, which were encountered in the present case, withdrawal can result in balloon fragment embolization.[2] The first point when encountering such a situation is to not lose wire access, before confirming the absence of vessel rupture, which can lead to more serious complications. Thus, our main concern when balloon rupture was detected was to maintain guidewire access during retrieval.

Murata et al[10] recommended the pull-through technique to remove the balloon fragment, using a cobra-head catheter as a "pusher" to facilitate pushing out the umbrella-like fragment from the sheath. Krishnamurthy et al[11] reported the case of a 70-year-old woman with end-stage renal disease who presented for treatment of in-stent stenosis in the outflow cephalic vein. An 8 × 80-mm balloon was used to treat the lesion, which ruptured at low pressure. The balloon became lodged within the struts of the stent and could not be retrieved despite many withdrawal attempts. Therefore, a covered stent was placed to trap the fractured fragment and prevent migration.[11] Their case is similar to our case, in which balloon rupture occurred with inflation at less than the rated burst pressure, which could be attributed to in-stent stenosis and possible friction with the stent edges. Alternatively, the torn end of the balloon could have become attached to the end of the sheath, leading to eversion and wrapping around the wire, which we believe happened in our case. Initially, the balloon could be moved over the wire but then resistance occurred with pulling the balloon into the sheath. The initial attempt at forcing the balloon into the sheath failed. Subsequently, the wire and balloon catheter could not be separated despite withdrawing the sheath back.

No definitive preferred type of balloon angioplasty catheter has been established for resistant venous stenosis. In our patient, the use of high-pressure balloons resulted in 7-month patency on follow-up imaging. However, this disagrees with the findings reported by Wu et al,[12] who compared the use of cutting balloons with that of high-pressure balloons for highly resistant venous lesions in patients requiring hemodialysis. They showed that the primary patency rates at 3 and 6 months were

significantly better after cutting balloon angioplasty than after high-pressure balloon angioplasty.[12]

In the present case, we believe that serial balloon upsizing to allow for better vessel preparation for definitive treatment could have avoided such complications. A scarcity of reports exist on balloon ruptures in central veins, and the true incidence of this complication in this group of patients is not known. The present report describes the management of balloon rupture in the setting of balloon angioplasty of in-stent stenosis of the left brachiocephalic vein.

CONCLUSIONS

Eversion of a ruptured balloon during angioplasty is a very rare complication and can interfere with retrieval over the wire. Surgical cutdown can be used for safe and complete removal of the balloon catheter.

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