Experience and Technique for the Endovascular Management of Iatrogenic Subclavian Artery Injury


Background: Inadvertent subclavian artery catheterization during attempted central venous access is a well-known complication. Historically, these patients are managed with an open operative approach and repair under direct vision via an infraclavicular and/or supraclavicular incision. We describe our experience and technique for endovascular management of these injuries.

Methods: Twenty patients were identified with inadvertent iatrogenic subclavian artery cannulation. All cases were managed via an endovascular technique under local anesthesia. After correcting any coagulopathy, a 4-French glide catheter was percutaneously inserted into the ipsilateral brachial artery and placed in the proximal subclavian artery. Following an arteriogram and localization of the subclavian arterial insertion site, the subclavian catheter was removed and bimanual compression was performed on both sides of the clavicle around the puncture site for 20 min. A second angiogram was performed, and if there was any extravasation, pressure was held for an additional 20 min. If hemostasis was still not obtained, a stent graft was placed via the brachial access site to repair the arterial defect and control the bleeding.

Results: Two of the 20 patients required a stent graft for continued bleeding after compression. Both patients were well excluded after endovascular graft placement. Hemostasis was successfully obtained with bimanual compression over the puncture site in the remaining 18 patients. There were no resultant complications at either the subclavian or the brachial puncture site.

Conclusion: This minimally invasive endovascular approach to iatrogenic subclavian artery injury is a safe alternative to blind removal with manual compression or direct open repair.

INTRODUCTION

The insertion of central vein catheters into the subclavian vein was first described by Aubaniac in 1952.1 Since that time, millions of central venous catheters have been placed every year by medical and surgical specialists into the femoral, internal jugular, and subclavian veins. These centrally placed catheters are often of large bore and can be paramount in the management of many patients who may require rapid volume resuscitation, hemodialysis, parenteral nutrition, or multiple drug therapy. Inadvertent arterial puncture with a small needle is usually benign and occurs about 5% of the time.2 The consequences can be much more severe if a large-caliber catheter is placed into the artery, and this is estimated to occur 0.1-0.8% of the time.3 Accidental intra-arterial cannulation has traditionally been treated with open surgery, utilizing a supraclavicular and/or infraclavicular approach. Herein, we describe our experience with the endovascular management of patients sustaining iatrogenic subclavian artery cannulation.

MATERIALS AND METHODS

We retrospectively reviewed our experience at New York University Medical Center. From 2001 until 2008, the vascular surgery department was
consulted for 20 patients who had unintentional cannulation of their subclavian artery during attempted access of their central venous vasculature. Nine patients had intra-arterial triple lumen catheters (7-French catheter), and 11 had intra-arterial introducer sheaths (8.5-French sheath). After addressing and/or correcting any existing coagulopathy and after informed consent, each patient was taken to the operating room. The intra-arterial catheter, along with the superior portion of the chest, periclavicular region, neck, and ipsilateral arm were prepped and draped in sterile fashion.

Under local anesthesia, a 4-French glide catheter was placed percutaneously via an ipsilateral, retrograde brachial approach (Fig. 1). A micropuncture technique, with or without ultrasound guidance, was utilized. The 4-French catheter was advanced into the proximal subclavian artery, and an arteriogram was performed to delineate the anatomy and intra-arterial puncture site prior to subclavian catheter removal (Fig. 2). Following this, the subclavian intra-arterial catheter was removed and bimanual pressure was applied from a supraclavicular and infraclavicular approach for 20 min (Figs. 3 and 4). After this, an arteriogram was performed. If any extravasation was demonstrated, pressure was held for an additional 20 min over the subclavian puncture site. A final repeat arteriogram was performed. If extravasation persisted, a 7-French sheath was placed in the brachial puncture site and a covered stent graft was used to exclude the damaged arterial wall segment. The brachial puncture site was compressed. If necessary, under local anesthesia, a small cutdown could be performed for direct brachial artery repair. An occlusion balloon was readily available, to be used if necessary during the procedure.

All patients underwent duplex ultrasonography 24-48 hr postprocedure to evaluate for persistent extravasation or pseudoaneurysm at the subclavian and brachial catheter sites.

RESULTS

Eighteen of the 20 patients were treated successfully with angiographically directed bimanual compression. Two of the 20 (10%) patients required covered stent grafts. No patient had any bleeding complications, hematoma, pseudoaneurysm, stroke, or evidence of distal embolization at either puncture site.

In this series, a covered stent graft (iCast; Atrium Medical, Hudson, NH) was used in two patients who had persistent extravasation. In these cases, a stiff guidewire was placed through the glide catheter, and the catheter was exchanged for a short 7-French sheath. The covered stent graft was then deployed over the stiff wire in the subclavian artery under fluoroscopic guidance, with particular attention to not cover the orifice of the internal mammary or vertebral artery. Post—stent deployment angiography demonstrated an excellent result with no further extraluminal extravasation after placement in both patients. The sheath and wire were removed, and manual pressure was placed over the brachial artery.

Duplex ultrasound examination at 24-48 hr postprocedure confirmed that no patient developed a pseudoaneurysm, hematoma, or continued extravasation at either puncture site. One of the stent-graft patients was lost to follow-up. The other stent-graft patient was asymptomatic with a patent stent graft at 14-month follow-up.

DISCUSSION

It is estimated that large-caliber (>7 French) cannula misplacement into an artery occurs approximately
0.1-0.8% of the time during attempted central line cannulation. Complications described in the literature include arteriovenous fistulas, pseudoaneurysms, hemothorax, strokes, and potential airway obstruction from expanding hematomas. A recent case series and review by Guilbert et al. demonstrated that immediate blind catheter removal from the artery with external compression resulted in a 47% major complication rate and 12% mortality. In contrast to this, patients who were taken to the operating room with removal of the catheter under direct vision with concomitant suture repair of the artery had 0% morbidity and mortality.

To our knowledge, our series of 20 patients with inadvertent subclavian artery catheterization treated by endovascular means is the largest of its kind in the modern literature. The majority of our patients were treated with 20 min of directed pressure over the puncture site. However, we believe that the success rate has much to do with the fluoroscopically guided bimanual pressure technique. The two patients who had continued extravasation were successfully treated with an iCast 10 mm covered stent. This stent was used as it is the lowest-profile covered stent presently available (7 French) and it was readily available to us at the time of the procedure. Both of these were male patients, and we were able to use manual compression at the brachial puncture site without having to perform a brachial artery cutdown. Had this been a concern or had these been female patients with smaller arteries, we would have proceeded with a brachial artery cutdown under local anesthesia to allow for direct suture repair of the brachial artery defect.

Reports of endovascular stent-graft treatment for arterial injuries began appearing in the literature over a decade ago. Most of the series were retrospective and very small in number. One of the largest studies in the literature involved 57 patients who underwent endovascular stent-graft repair for penetrating subclavian artery injuries. Early complications in this group involved three patients (5%) who presented with graft occlusion and non-limb-threatening ischemia. These three patients were managed successfully with a second endovascular procedure. Review of the literature on open repair of traumatic subclavian artery injuries demonstrated early failure rates by Mckinley et al. (12 of 236) and Degiannis et al. (three of 54) to be about 5% as well. Twenty-five of the 57 endovascular patients were followed up with a mean duration of 48 months. Five of the 25 patients (20%) developed an angiographically significant stenosis that required balloon angioplasty. Three patients (12%) presented with non-limb-threatening occlusions, and these were managed conservatively. Most of the long-term occlusions and significant stenoses involved the more rigid stent grafts. Other series, by Kasirajan et al., Phipp et al., and Sitzen et al., also confirm superiority of more flexible stent grafts such as the Viabahn/Hemobahn (W.L. Gore, Flagstaff, AZ).
when compared to the more rigid stent grafts in the subclavian artery.

Based on the presented literature, the use of a more flexible stent graft might be a better option in the subclavian artery. Hopefully, lower-profile flexible stent grafts will be available in the near future. Alternatively, if a larger sheath is needed to deliver a more flexible stent graft, a small brachial artery cutdown under local anesthesia and direct repair would be advised.

One other option available with brachial access is the use of proximal balloon occlusion if it was decided that the patient would benefit from open repair and/or if no covered stent were available. The balloon would be placed via a sheath in the ipsilateral brachial artery for proximal control of bleeding. In this case, we would most likely heparinize the patient prior to balloon occlusion in order to prevent thromboembolic complications.

The use of percutaneous closure devices for the removal of central venous catheters from inadvertent arterial catheterizations has been reported and was first described over 8 years ago. Since then, there have been several reports of the successful treatment of iatrogenic arterial injury with closure devices. These devices, however, were designed for the femoral artery, not the softer subclavian artery. In addition, there have been reports of significant complications of percutaneous closure devices such as complete arterial thrombosis and/or distal embolization with resultant ischemia.

Therefore, we favor our endovascular method of treatment when dealing with these iatrogenic arterial injuries.

CONCLUSION

Blind removal of large-bore catheters inadvertently placed in the subclavian artery can lead to high morbidity, while traditional open repair can be difficult and usually requires general anesthesia. We present a minimally invasive endovascular option for iatrogenic subclavian artery injury that is a safe alternative to blind catheter removal or direct open repair.

REFERENCES