Diagnostic and Interventional Imaging (2017) xxx, xxx—xxx

ORIGINAL ARTICLE /*Interventional Imaging*

Outcomes of type 2 endoleaks detected on venous phase CT arteriography

M.D. McDonald[a], H.H. Paik[a], R. Fairman[b], P. Foley[b], B. Jackson[b], G. Wang[b], S.W. Stavropoulos[a,*]

[a] *Department of radiology, division of interventional radiology, Perelman school of medicine, university hospital of Pennsylvania, 3400, Spruce street, 19104 Philadelphia, PA, United States*
[b] *Department of vascular surgery, university hospital of Pennsylvania, 3400, Spruce street, 19104 Philadelphia, PA, United States*

KEYWORDS
Abdominal aortic aneurysm;
Type 2 endoleak;
Embolization

Abstract
Purpose: The majority of type 2 endoleaks (T2EL) are identified on computed tomography angiography (CTA) both on arterial and venous phase. There is a subset of T2EL that are demonstrated only on venous phase CTA. This study was done to report the outcomes of T2EL detected only on venous phase CTA.
Materials and methods: A total of 261 consecutive T2EL treated via embolization were reviewed for the presence of endoleak demonstrated only on venous phase CTA. A group of 16 patients (12 men, 4 women; mean age, 80.1 years) was identified who had pre-embolization venous phase T2EL. Patients were evaluated for presence of T2EL after embolization, change in aneurysm diameter, and need for further intervention.
Results: The prevalence of venous phase T2EL was 6.1% (16/261; 95%CI: 3.2%—9.0%). On post-embolization CTA, the rate of successful embolization at 6 months was 2/12 (17%; 95%CI: 0%—38%). At 6-month follow-up, mean change in aneurysm diameter was +2.3 mm ($n = 12$; 95%CI: −0.5 mm to +5.0 mm). In total, 4/16 (25%; 95%CI: 4%—46%) underwent re-embolization and 4/16 (25%, 95%CI: 4%—46%) underwent conversion to open repair. There was one aneurysm rupture, which was successfully treated surgically.
Conclusion: These results suggest that venous phase T2EL are not as responsive to embolization as standard T2EL and emphasize the need to follow patients with venous phase T2EL closely.

* Corresponding author.
E-mail address: stav@uphs.upenn.edu (S.W. Stavropoulos).

https://doi.org/10.1016/j.diii.2017.11.004
2211-5684/

Type 2 endoleak (T2EL) is a common complication after endovascular aneurysm repair (EVAR), occurring in 20 to 25% of patients who undergo this procedure [1,2]. T2EL are due to collateral flow into the aneurysm sac [3], most commonly from lumbar arteries or the inferior mesenteric artery (IMA) [4]. Small T2EL can spontaneously resolve without intervention. However, T2EL can become clinically significant, leading to aneurysm growth and even aneurysm rupture [5]. Triphasic computed tomography angiography (CTA) and Doppler ultrasound are the most commonly used imaging modalities to evaluate for the presence of endoleak and aneurysm sac growth. CTA has been shown to have a sensitivity of 92% in the detection of endoleaks [6–8].

To prevent growth and rupture, T2EL have been treated by transarterial (TA) or translumbar (TL) embolization with metallic coils, N-butyl cyanoacrylate (NBCA) glue and/or ethylene vinyl alcohol copolymer, with high rates of successful embolization [9–11]. Treatment is reserved for patients with T2EL and expanding aneurysm sacs. Both methods have been shown to be effective with treatment success rates approaching 62.5 to 80% [12–14]. Treatment success has been defined as no evidence of endoleak and/or aneurysm enlargement on follow-up CTA. While most T2EL are demonstrated on both arterial phase and venous phase imaging [15], some are only visualized on venous phase. While venous phase endoleaks have been thought to be less concerning that those seen on arterial phase imaging, this subset of endoleaks has not been well studied.

The purpose of this study is to report on the outcomes of T2EL detected only on venous phase CTA.

Materials and methods

Institutional review board (IRB) approval was obtained for this retrospective study. Patients were identified by a query of all patients treated by endoleak embolization between October 2001 and June 2015 at our institution. A total of 261 patients who underwent embolization of T2EL were identified. These were patients who were referred for endoleak embolization due to the presence of an endoleak and aneurysm growth.

Image review

Two radiologists separately reviewed a total of 261 consecutive type 2 endoleaks for the presence of pre-embolization endoleak visible only on the venous phase of a 3-phase CTA. Endoleaks visible only on venous phase were classified as venous phase endoleaks. A group of 16 patients (12 men, 4 women) with a mean age of 80.1 years was identified who had pre-embolization venous phase T2EL with post-embolization CTAs available for evaluation. The prevalence of venous phase T2EL among all T2EL that were embolized was 6.1% (16/261, 95%CI: 3.2%–9.0%). Fig. 1 compares an example of a standard T2EL with a venous phase T2EL. The venous phase T2EL demonstrates no evidence of endoleak on arterial phase imaging, compared to standard T2EL which shows a distinct nidus of flow on the arterial phase of the CTA.

A longitudinal survey of each patient's records was done, measuring the change in aneurysm size following endoleak embolization at each follow-up CTA. Data that was recorded included the maximal transverse diameter of the aneurysm sac, presence of a persistent endoleak after embolization, the need for re-embolization, whether or not the patient was converted to an open aneurysm repair, and the incidence of aneurysm rupture. Successful embolization on follow-up was defined as the absence of persistent endoleak on CTA and a stable or decrease aneurysm sac size. Re-embolization was defined as repeat embolization of a persistent endoleak. Patients with persistent endoleaks and/or aneurysms that continued to expand underwent re-embolization or were converted to open repair.

Endoleak embolization

All patients underwent endoleak embolization due to presence of an endoleak and expansion of the aneurysm sac. Embolization of the endoleak was performed using a translumbar approach using previously described techniques [15]. This technique involves embolizing the endoleak sac nidus, which breaks the communication between the multiple arteries that supply the endoleak, leading to more durable results. The endoleak sac was selected via translumbar approach and translumbar aortography was performed. The endoleak sac was accessed by using set landmarks as determined by prior CTA. The patient was placed prone, and the endoleak was accessed via a direct puncture under fluoroscopic guidance. A 5-Fr introducer sheath/needle (Angiotech, Gainesville, FL, USA) is directed toward the endoleak cavity with guidance provided by fluoroscopy and C-arm CT. When the endoleak cavity is accessed, blood return will be seen coming from the catheter. Translumbar embolization was performed from via a left flank approach, in 13 patients and was performed from right translumbar (transcaval) approach in 3 patients. Contrast injection can confirm catheter placement into the sac and will often demonstrate the feeding vessels.

A combination of platinum coils and NBCA liquid embolic agent (Trufill®, Cordis, Miami Lakes, FL, USA) placed through the 5-Fr catheter were used for embolization. Technical success was defined as absence of endoleak visible on post-embolization angiogram. Fig. 2 demonstrates intraprocedural digital subtraction arteriogram demonstrating translumbar catheterization of the endoleak sac and fluoroscopic imaging following coil and NBCA embolization of the endoleak sac. All patients were referred for follow up with 1-month, 6-month, and 12-month then yearly CTA to evaluate for presence of endoleak and aneurysm growth. Successful embolization was defined as no residual endoleak on imaging and stable or shrinking aneurysm. There were no post-procedural adverse events per the Society of interventional radiology CTCAE criteria.

Results

All 16 patients were treated with translumbar embolization of the endoleak sac with platinum coils and NBCA due to aneurysm expansion. Patients with venous phase T2EL had an average change in aneurysm diameter of +7.6 mm ($n = 16$; 95%CI: +3.4 mm to +11.8 mm) from date of EVAR to date of embolization. The portion of the aneurysm that enhanced

Please cite this article in press as: McDonald MD, et al. Outcomes of type 2 endoleaks detected on venous phase CT arteriography. Diagnostic and Interventional Imaging (2017), https://doi.org/10.1016/j.diii.2017.11.004