Morphologic characteristics and endovascular treatment of primary infrarenal aortic dissections

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ABSTRACT

Objective: We report the morphologic characteristics and endovascular treatment of primary infrarenal aortic dissections (PIRADs).

Methods: A retrospective study was conducted with 38 consecutive PIRAD patients between January 2010 and May 2016 in our vascular center. Patient demographics, morphologic characteristics, endovascular modalities, and periprocedural and follow-up outcomes were recorded. Patients with symptomatic PIRADs or asymptomatic PIRADs of a maximum diameter >30 mm were indicated for endovascular aneurysm repair (EVAR). We proposed a morphologic categorization of PIRADs into two types (I and II) according to the location of the entry tears and an endovascular strategy for treating type I PIRADs with tubular stent grafts (SGs) and type II PIRADs with bifurcated SGs.

Results: According to the categorization, the study recruited 13 patients with type I and 25 patients with type II PIRADs. The patients were predominantly men, with an average age of 60.8 ± 15.2 years. Type I PIRADs usually had larger true lumens (22.6 ± 6.3 vs 13.6 ± 4.0 mm; $P = .002$) and relatively smaller false lumens (8.4 ± 2.3 vs 19.9 ± 16.1 mm; $P = .012$). Type II PIRADs had more entry tears (2.2 ± 0.6 vs 1.7 ± 0.6; $P = .024$) and longer dissections (109.4 ± 38.8 vs 73.9 ± 39.0 mm; $P = .011$). All patients underwent EVAR, with 19 tubular and 22 bifurcated SGs. One patient died during the hospital stay. The technical success rate was 94.8% (36/38), and the clinical success rate was 97.4% (37/38). During follow-up of 36 patients for 28.8 ± 17.7 months, 2 patients with type II PIRADs developed left iliac extension occlusion at 3 and 6 months after EVAR, and only 1 patient underwent reintervention. All patients survived throughout the follow-up. No endoleak or aortic enlargement was observed. Computed tomography angiography demonstrated a patent infrarenal aorta with completely thrombosed false lumen in all PIRAD patients (36/36 [100.0%]). In both types of PIRAD, EVAR yielded a significant decrease in the maximum diameter of the infrarenal aorta, with a significant increase in the true lumen size and a significant decrease in the false lumen size ($P < .05$).

Conclusions: The morphologic categorization of PIRADs based on the location of the entry tears appeared to be feasible. The endovascular strategy was safe and effective, with high rates of technical success and clinical success and favorable follow-up outcomes. (J Vasc Surg 2018;67:1380-8.)

Primary infrarenal aortic dissections (PIRADs) are defined as any aortic dissections of the primary entry tear located at the infrarenal aorta. Theoretically, the dissection can propagate in an anterograde manner to the iliac arteries or in a retrograde manner to the suprarenal aorta. Clinically, PIRADs are uncommon. Clinical manifestations of PIRADs are nonspecific[1-7] and include abdominal pain, chest or back pain, abdominal pulsatile mass, shock due to aortic rupture, and even splanchnic or lower extremity ischemia.

Most extant publications are case reports with no more than five patients.[1,2] Similar to the condition of other aortic entities, PIRADs can be treated conservatively (with antihypertensive therapy), surgically, or endovascularly.[1-3] Conservative treatment does not efficiently prevent the propagation of the dissections, and open surgery might result in high rates of morbidity and mortality. Therefore, endovascular aneurysm repair (EVAR) has been widely accepted[4,5] as the preferred option for PIRADs because of its minimally invasive characteristics and lower incidence of perioperative complications. However, to the best of our knowledge, few studies have reported the morphologic characteristics of endovascular strategy for treating PIRADs.

Thus, in this study, we proposed a morphologic categorization of PIRADs into two types, type I and type II, and a corresponding endovascular strategy. This study summarizes our single-center experience of treating 38 consecutive PIRADs with EVAR and investigates the safety and effectiveness of this strategy.

METHODS

Population of patients. This retrospective study was conducted between January 2010 and May 2016 with PIRAD inpatients who were admitted to the vascular center of Zhongshan Hospital, Affiliated with Fudan University, Shanghai, China. A total of 43 consecutive PIRAD inpatients were identified. Among them, four

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Author conflict of interest: none.

Additional material for this article may be found online at www.jvascsurg.org.

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The editors and reviewers of this article have no relevant financial relationships to disclose per the JVS policy that requires reviewers to decline review of any manuscript for which they may have a conflict of interest.

0741-5214

http://dx.doi.org/10.1016/j.jvs.2017.05.125

patients were treated conservatively for financial reasons, and one patient was treated surgically. The remaining 38 patients received EVAR and were recruited for this study.

Patient demographics, including age, gender, comorbidities, and clinical manifestations, were collected. Morphologic characteristics, endovascular modalities, and periprocedural and follow-up outcomes were also reviewed. All patients included in the study signed an informed consent form before EVAR. This study was approved by the Ethics Committee Institutional Review Board of Zhongshan Hospital, Affiliated with Fudan University, Shanghai, China.

Morphologic characteristics and measurements. Morphologic characteristics were observed and analyzed using TeraRecon software (TeraRecon, San Mateo, Calif) based on computed tomography angiography (CTA) imaging. These included the numbers of primary and secondary entry tears, status of the false lumen, maximum diameter of the infrarenal aorta, diameters and ratios of true and false lumens, and length of dissection.

Primary entry tear referred to the entry tear with the minimum proximal distance to the lower renal artery, and secondary entry tears referred to any other distal entry tears. The proximal neck was defined as the distance between the primary entry tear and the lower renal artery. The status of the false lumen included patency, partial thrombosis, and complete thrombosis. Patency was defined as contrast material filling all the false lumen. Partial thrombosis was defined as the concurrent presence of both blood flow and thrombus in the false lumen. Complete thrombosis was defined as the presence of thrombus without any blood flow in the false lumen. The true lumen ratio (TLr) and false lumen ratio (FLr) were used to evaluate relative changes in the infrarenal aorta and were calculated by dividing the diameters of the true and false lumens, respectively, by the maximum diameter of the infrarenal aorta: $TLr = TL/(TL + FL)$ and $FLr = FL/(FL + TL)$.[6]

For symptomatic PIRADs, the acute phase was defined as within 2 weeks after symptom onset; the subacute phase, as the following 2-month period; and the chronic phase, as anything thereafter. Because of the unknown nature of the asymptomatic PIRADs, they were all categorized in the chronic phase.

PIRAD categorization. The PIRAD categorization was established on the basis of the distribution of primary and secondary entry tears. Initially, the infrarenal aorta was divided into two distinct segments, zone 1 and zone 2. Zone 1 covered most of the infrarenal aorta and ended at 15 mm proximal to the aortic bifurcation (AB); zone 2 covered the remaining part of the infrarenal aorta. The iliac arteries were named zone 3.

Accordingly, PIRADs were stratified into two types, type I and type II (Supplementary Fig, online only; Fig 1). In detail, type I referred to PIRADs with all entry tears at zone 1. Type II was defined as any other PIRADs, including the following conditions: (1) any dissections with the primary entry tear at zone 2; and (2) dissections of primary entry tear at zone 1 and at least one secondary entry tear at zone 2 or zone 3, regardless of whether the corresponding false lumens were connected or isolated.

ARTICLE HIGHLIGHTS

- **Type of Research:** Single-center retrospective cohort study
- **Take Home Message:** Primary infrarenal aortic dissection was defined in 38 patients as type I, with aortic tear 15 mm proximal to the bifurcation, and type II, with at least one tear more distally in the aorta or the iliac arteries. All patients underwent endovascular repair using straight and bifurcated stent grafts, with a mortality of 2.6%, technical success of 94.8%, no endoleak or aortic enlargement at 28.8 months, and thrombosis of the false lumen in all.
- **Recommendation:** This study suggests a classification and endovascular repair for patients with primary infrarenal aortic dissections.

EVAR strategy. Before EVAR, medical treatment was routinely performed for symptomatic patients, including analgesic therapy and antihypertensive management with beta blockers, calcium channel blockers, and other agents if necessary (target blood pressure of 130/80 mm Hg).

Patients with symptomatic PIRADs or asymptomatic PIRADs with a maximum diameter >30 mm[5,6] were indicated for EVAR. Symptomatic PIRADs referred to those with signs of impending rupture, persistent abdominal pain, or lower limb or splanchnic ischemia. Relative or absolute contraindications[8] to EVAR were as follows: hemodynamic instability or hypovolemic shock, coagulopathy, impaired renal function, known allergy to contrast media, and infection within the target vasculature.

The detailed endovascular techniques for PIRADs were previously described elsewhere.[9] In this study, we established the following principles of EVAR for PIRADs. First, all the entry tears were intended for repair to ensure favorable aortic remodeling and clinical outcomes. If possible, but not compulsory, the normal aorta was preferred for both the proximal and distal landing areas of the stent graft (SG). Second, the endovascular strategy was based on the PIRAD categorization. Tubular SGs were the preferred choice for type I PIRADs, whereas bifurcated SGs were the first-line option for type II PIRADs. Under certain circumstances, such as the presence of a narrow infrarenal aorta (diameter <18 mm) and a narrow AB (diameter <14 mm), a tubular SG for