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RESEARCH LETTER

Intravascular Ultrasound in the Management of Venous Thoracic Outlet Syndrome

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Venous thoracic outlet syndrome (VTOS) is characterised by compression of the subclavian vein (SCV) as it passes through the thoracic outlet bordered by the clavicle, first rib, and scalene muscles. Owing to repetitive venous compression during arm movement, fibrosis and, eventually, thrombosis occurs, which may lead to the post-thrombotic syndrome (PTS). To decrease the incidence of PTS, current treatment strategies focus on recanalisation and long term SCV patency, and include oral anticoagulation therapy (OAC), thoracic outlet decompression (TOD), surgical thrombectomy, and endovascular interventions (thrombolysis, venoplasty, thrombus aspiration, and stenting).[1] Owing to the pathophysiology and challenging anatomical region, intravascular ultrasound (IVUS) may be of added value to achieve this objective.

Using a catheter based ultrasound transducer, IVUS facilitates evaluation of the vessel wall and lumen, allowing for accurate measurements of length, diameter, and cross sectional area. Furthermore, owing to the distinction of the intima from surrounding tissue, intraluminal problems may be identified.[2] Another possible advantage of IVUS over venography is the creation of cross sectional instead of unidirectional images.

Nowadays, IVUS is commonly used in coronary interventions to visualise plaques, optimise stent implantation, and improve long term outcome.

In various studies on iliofemoral venous disease and one VTOS series, IVUS was more sensitive than venography in determining the degree and length of the stenotic lesion and detecting intraluminal disease such as thrombus, septations, and frozen valves.[3–5]

In very select VTOS cases with severe persisting symptoms and angioplasty resistant intraluminal damage, dedicated stents may be used to restore patency. However, long term data on the safety and efficacy of SCV stents is lacking. Owing to the highly dynamic nature of the thoracic outlet, subclavian stents potentially have a limited durability, especially without TOD. In particular, IVUS may be of added value in VTOS, considering the risk of intraluminal fibrosis and septations. Furthermore, IVUS assisted stent placement allows for accurate visualisation of the lesion, precise sizing, and stent deployment, potentially increasing stent patency and decreasing the risk of PTS. Lastly, IVUS can be used with the arm in neutral and elevated positions, to judge the adequacy of interventional procedures.

Recently, IVUS was incorporated in a treatment protocol of selected patients with VTOS as an adjunct to TOD, to assess the vein for intraluminal problems and help with endovascular procedures. Since January 2019, 10 IVUS procedures were performed in eight patients. IVUS images were obtained using the Volcano Core M2 system and Visions PV 0.035 catheter (Philips Healthcare, Best, the Netherlands). Five procedures were done via the brachial or basilic vein, and five transfemorally. Four patients with prior unsuccessful recanalisation (thrombolysis or venoplasty) were treated by TOD followed by venography with IVUS because of persisting complaints. On venography, all four showed a significant SCV stenosis, but IVUS confirmed the stenosis in three and showed a non-significant lumen reduction in one. The first three received stent placement; the latter received only OAC.

IVUS was performed in one patient with a chronic occlusion and severe persisting symptoms. After recanalisation, venography showed a short stenosis, while IVUS revealed a significantly longer segment. In this study, TOD was performed with adjunctive IVUS assisted stent placement covering the complete length of the stenosis.

In two patients with recurrent SCV thrombosis after previous treatment (i.e., TOD and TOD with IVUS assisted stent placement), venography after recanalisation showed a non-significant residual and a mild in stent stenosis, respectively. However, IVUS showed a significant lumen reduction in the first patient after which a stent was placed, and a long in stent thrombus due to stent fracture in the other patient for which a stent in stent was placed (Fig. 1). The stent fractured on a residual ventral stump of the first rib, which was resected.

In two patients, venography with IVUS was performed because of residual complaints after TOD. Venography did not show distinct intraluminal problems, while IVUS showed extensive septations. As both patients were young with mild complaints, no additional treatment was performed.

All six implanted stents were dedicated Venovo (BD Peripheral Vascular, Tempe, AZ, USA) stents: diameters ranged

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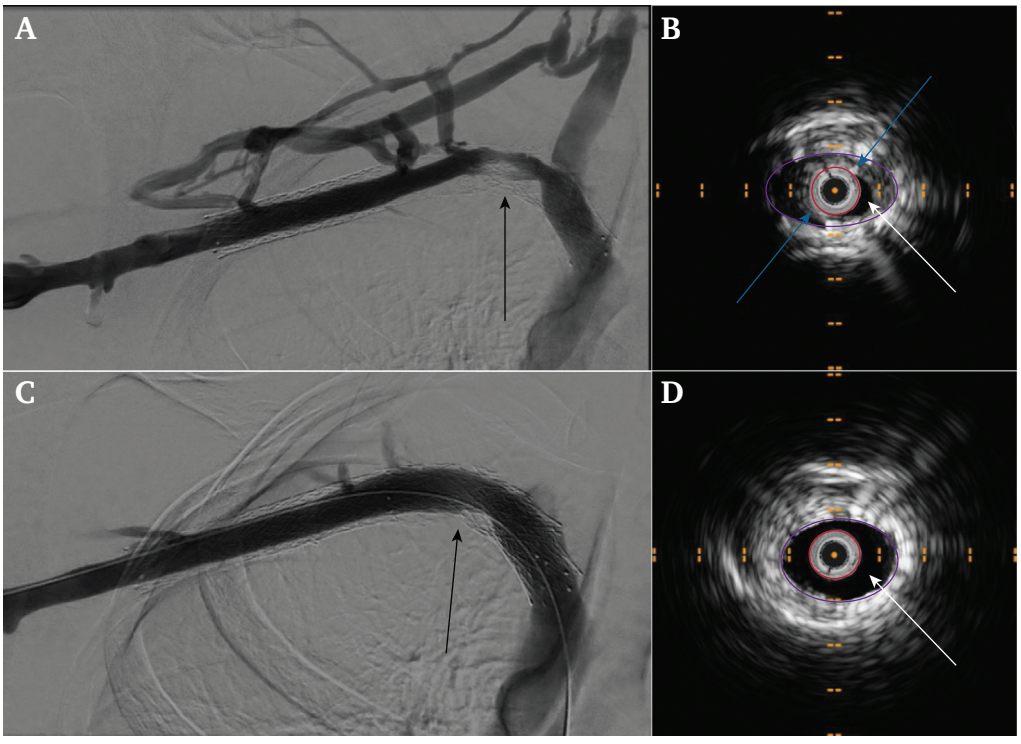

Figure 1. Images of patient with recurrent subclavian vein thrombosis after previous thrombolysis, thoracic outlet decompression, and stent placement. (A) Venography before treatment showing an in stent stenosis with collaterals. (B) Intravenous ultrasound (IVUS) before treatment showing severe lumen reduction with in stent thrombus (blue arrow). (C) Venography after venoplasty and stent in stent placement showing improved calibre and reduction of collaterals. (D) IVUS after treatment showing improved calibre and adequate stent apposition. Black arrow = location of IVUS image; white arrow = vein lumen; violet = stent; red = IVUS transducer.

from 10 to 12 mm and lengths from 40 to 120 mm. Stent apposition was assessed with IVUS in all stented veins. In one, venography showed adequate stent deployment, while IVUS demonstrated inadequate stent apposition that was resolved by balloon venoplasty. All stented patients received oral anticoagulation for at least six months after implantation.

Despite IVUS being costly and potentially time consuming, this early experience with IVUS assisted venography demonstrated its added value over plain venography in VTOS management. IVUS led to a strategy change in three procedures. In two, stent placement was optimised. IVUS helped define the degree of stenosis, identify intraluminal problems, decide whether stent placement was required, and verify if stent apposition was appropriate.

In conclusion, IVUS assisted venography played an important role in determining and performing the optimal treatment strategy in selected patients with VTOS with intraluminal damage. To confirm whether the addition of IVUS results in an improved clinical outcome, prospective long term follow up of a larger cohort is warranted. Therefore, a TOS registry, which will be extended internationally, was recently started.

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