The enduring success of the DRIL technique and new advances in dialysis access

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Hemodialysis access-induced digital ischemia (HAIDI) is a rare but potentially devastating complication of arteriovenous (AV) access.[1,2] It is estimated that 1%-8% of all access[2] will develop symptoms, ranging from hand coolness and mild claudication to ischemic rest pain, tissue loss, and digital gangrene.[1] Advanced age, female sex, diabetes, peripheral arterial disease, large outflow conduits, brachial artery inflow, multiple prior access procedures, and prior episode of steal are some of the risk factors for developing HAIDI.[3] Timely diagnosis and treatment are imperative to decrease the risk of permanent neurologic and/or tissue damage.

Distal revascularization and interval ligation (DRIL) was first described in 1988 by Schanzer et al[1] as treatment option for HAIDI. Prior to this, steal was primarily addressed by access ligation. DRIL is an attractive option in treating HAIDI, since it preserves access and has been shown to have high success rates in restoring distal perfusion.[2] Other treatment options have been developed over the years including ligation of the distal radial artery, banding, revision using distal inflow (RUDI), and proximalization of arterial inflow (PAI).

In the original case series describing DRIL, Schanzer et al[1] demonstrates its success through three cases. In the first, a 40-year-old man developed pain, decreased strength, and diminished sensation of the left hand after the creation of a radiocephalic arteriovenous fistula (AVF). The second and third cases involved men in their sixth decades of life, who presented with motor and sensory deficits after upper arm arteriovenous grafts (AVG) creation. In all cases, the artery distal to the AVF was ligated and flow was maintained by a bypass constructed with a segment of reversed saphenous vein. All patients had complete resolution of symptoms with preserved AV access.

Doppler and pneumoplethysmographic pulse wave recordings were used to detect blood pressure of the affected limb throughout the cases.[1] The pressure observed during compression of the fistula preoperatively would provide an idea of how pressure should increase after successfully completing the procedure. Pressures were also recorded between bypass and ligation steps to monitor an interval increase in the blood pressure distal to the anastomosis. More techniques have been developed to intraoperatively monitor the success of various procedures used to treat HAIDI, including digital photoplethysmography, intraoperative flow monitoring using Doppler ultrasound, and intra-arterial pressure measurements.[4]

While there are no limitations mentioned in the article, it is evident from the sample size that the results of this paper were more anecdotal than practice changing at the time of publication. Nevertheless, the work by Schanzer et al[1] has been cited over 176 times. Several larger studies reported on safety and efficacy of this procedure supporting its wide adaptation and establishing it as the "gold-standard" treatment for HAIDI.[2,3,5]

There are no hard and fast guidelines for the management of HAIDI. In the past, access ligation was considered the gold-standard for treatment of HAIDI with an estimated symptom resolution rate of 93%.[2] However, it sacrificed dialysis access in the process. The DRIL procedure has comparable outcomes, while maintaining access.[2] The need for reintervention in these patients, either because of recurrence or residual symptoms, is as low as 6%. Over the years, alternatives in the approach have been proposed. In lieu of the saphenous vein bypass conduit, PTFE grafts and ipsilateral arm vein have been used.[6,7] Additionally, variations in the operative steps for patients with difficult anatomy have also been introduced.[8]

While DRIL might be the most effective treatment for HAIDI, there is a reluctance to ligate normal arteries supplying the distal arm, which has led to the development of alternative treatment options including PAI. This technique does not sacrifice natural arterial continuity. Proximalization of the arterial anastomosis increases flow to the forearm by increasing pressure at the point between the distal circulation and the dialysis access. It also initiates collateral flow at a higher point in the arm, which is advantageous in preventing and/or treating ischemic symptoms in the hand. Gradman et al[9] demonstrated that PAI appears to be as effective by achieving a similar increase in distal flow.

Since the release of the publication by Schanzer et al 36 years ago,[1] significant advances in AV access creation and management have been made. Breakthroughs in endovascular techniques have arguably been a more impressive

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J Vasc Surg Cases Innov Tech 2024;10:101490

2468-4287

https://doi.org/10.1016/j.jvscit.2024.101490

change over the past few decades. Perfusion angiography allows for rapid characterization of access dysfunction in real time. Other endovascular devices, such as drug-coated balloons, covered stents, and coils, have improved surgeons' ability to maintain access patency and supplement operations like DRIL.[10,11] Endovascular AVF creation in the mid- to proximal-forearm has been shown to have promising early results in recent trials.[11] Its side-to-side anastomosis reduces shear stress, which, coupled with the avoidance of manual tissue handling, reduces the risk of developing neointimal hyperplasia (NIH) and subsequent stenosis and/or thrombosis.

Another major change in the landscape of dialysis access has been the emphasis on procedural planning. In 2019, the Kidney Disease Outcomes Quality Initiative updated their guidelines to include the End Stage Kidney Disease (ESKD) "Life Plan."[3] Prior to this, the Fistula First Breakthrough Initiative (FFBI) dominated practice rule-of-thumb, which was AVF creation for everyone with suitable anatomy. However, patients' outcomes over the past decade demonstrated that AVG creation and central venous catheter (CVC) placement could benefit select groups, particularly those with limited ability to withstand multiple operations necessary in achieving a mature and functional AVF. The Life Plan urges providers to consider all patient-related factors before creating the "right dialysis access for the right patient at the right time." Additionally, the importance of careful procedural planning to preserve available access sites and conduits for future access creation is emphasized. Reducing procedural burden also has a great impact on incurred costs to the United States healthcare system, which spent $24.2 billion on hemodialysis-related services in 2021.[12]

Prevention of access dysfunction and improving AV access maturation rates will continue to be the focus of hemodialysis research and innovation. Devices providing pneumatic compression to improve preoperative vein diameters are in the early stages of development. The recently approved VasQ scaffold (Laminate Medical Technologies, Israel) has been shown to improve maturation and patency rates by optimizing configuration of the anastomosis.[11] To reduce NIH development after access creation, there has been a focus on bioengineering alternative materials, such as gels, grafts, and sirolimus wraps. Management of central venous occlusive disease will continue to evolve as well. The Surfacer device (Bluegrass Vascular, San Antonio, TX) was recently created to provide right-sided central venous access in patients with CVS by creating a new track that bypasses the occluded segment.[11]

From surgical techniques to patient care, there has been tremendous growth in dialysis access management over the last few decades. Since the introduction of DRIL, other surgical techniques and endovascular adjuncts to treat HAIDI have been developed. We have also witnessed a shift in practice standards from the FFBI to ESKD Life-Plan, which has recentered the approach in treating dialysis patients. For hemodialysis, the future is bright.

DISCLOSURES

None.

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