 Patency of tertiary vascular access in hemodialysis patients: case series

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ABSTRACT

Background: Transposed brachio-basilic arteriovenous fistula (TBB-AVF) or arteriovenous graft (AVG) can be considered when primary and secondary vascular access options have been exhausted. Evidence that compared both procedures remains scarce. We aimed to report and describe the effectiveness of TBB-AVF and AVG as tertiary vascular access, reviewing literature about the advantages of each procedure.

Case Presentation: We presented a series of end-stage renal disease (ESRD) patients needing tertiary vascular access to compare each procedure’s effectiveness. Our study included 17 patients with ESRD and multiple vascular access failures who needed tertiary vascular access for hemodialysis between January 2019 and August 2022. Patency in 6 months and 1 year were compared between TBB-AVF and AVG using the Kaplan–Meier curve. The early failure rate was 14.4% for TBB-AVF and 87.5% for AVG. TBB-AVF had a better patency rate than AVG (p=0.005; log-rank). Cumulative patency rates in six months and one year were 91.7% and 85.7% for TBB-AVF compared to 87.5% and 16.7% for AVG, respectively.

Conclusion: The creation of TBB-AVF should only be suggested if primary and secondary vascular access options have been exhausted. The TBB-AVF was more effective in functional patency than AVG as tertiary vascular access.

Keywords: Arteriovenous Fistula, Arteriovenous Graft, Tertiary, Transposition, Vascular Access.

CASE PRESENTATION

Case series of 17 consecutive ESRD patients diagnosed with ESRD who needed tertiary vascular access between January 2019 and August 2022. Patency in 6 months and 1 year were compared between TBB-AVF and AVG using the Kaplan–Meier curve. The early failure rate was 14.4% for TBB-AVF and 87.5% for AVG. TBB-AVF had a better patency rate than AVG (p=0.005; log-rank). Cumulative patency rates in six months and one year were 91.7% and 85.7% for TBB-AVF compared to 87.5% and 16.7% for AVG, respectively.

INTRODUCTION

High rates of arteriovenous fistula (AVF) maturation failure, recurrent thrombosis of arteriovenous graft (AVG), central venous catheter (CVC) related-infection, and central stenosis make planning and maintenance of vascular access sites the primary objectives of End-Stage Renal Disease (ESRD) treatment.1 When vascular access creation in the forearm (primary and secondary vascular access) is not possible, tertiary vascular access is needed. However, the preferred tertiary vascular access type has yet to be determined. Despite some studies showing clear advantages of using transposed brachio-basilic (TBB) AVF as tertiary vascular access compared to AVG, the transposed fistula has disadvantages, such as a more complex operation and a longer waiting time until cannulation is allowed.2–4 Recent studies have shown that AVG and TBB-AVF have comparable patency rates; AVG has also been favored due to its simplicity, shorter time to cannulation, and lower primary failure rate.5–6

Studies that compare the effectivity of TBB-AVG and AVG as tertiary vascular access still need to be made available. In this study, we presented a case series of patients with ESRD who needed tertiary vascular access for hemodialysis. We aimed to report and describe the effectiveness of TBB-AVF and AVG as tertiary vascular access, reviewing literature about the advantages of each procedure.

CASE PRESENTATION

Case of 17 consecutive ESRD patients who needed tertiary vascular access between January 2019 and August 2022 was studied retrospectively in a single-center tertiary hospital at Prof. Ngorah General Hospital, Bali. All patients diagnosed with ESRD with a history of primary and secondary vascular access malfunction in the upper extremities and a patient who underwent the creation of TBB-AVF and/or AVG as tertiary vascular access in the time frame were included.

Vascular mapping by ultrasound imaging has been done to confirm the presence of the basilic vein. Before being used, the basilic vein had to be at least 3 mm in diameter. The smaller basilic vein may be evenly dilated with heparinized saline by increasing the pressure applied to the vein. The anesthesia method used was either local anesthesia or general anesthesia. Before the incision was done, 2 g of cefazolin was administered to prevent infection.

Operative Procedure

The procedure was performed by a single cardiothoracic and vascular surgeon, also one of the authors in this study. The TBB-AVF was created with a single-stage procedure, including an incision from the antecubital fossa to the axilla of the patient’s upper arm. The basilic vein may be identified, exposed, and dissected circumferentially. Collateral branches of the vein were ligated. The medial brachial cutaneous nerve was protected throughout the isolation process. With heparinized saline, the isolated basilic
Figure 1. Anatomy of the upper arm during a basilic vein transposition.

Figure 2. Curved brachio-axillary arteriovenous graft in the right upper limb.

Figure 3. A: Exposed basilic vein was superficially transposed through the subcutaneous tunnel (arrow); B: End-to-side anastomosis between basilic vein and brachial artery (circle).

Figure 4. Kaplan-Meier curve depicts patency rate of TBB-AVF and AVG.

vein was dilated and inflated. Over the cubital segment of the brachial artery, a 2 cm-long longitudinal incision was created. The brachial artery was then exposed and circumferentially dissected. A subcutaneous tunnel was made below the anterior surface of the upper arm from the axilla to the antecubital fossa. The basilic vein at the antecubital fossa was transected and guided to the dissected brachial artery wound. Superficially transposed the vein through
The subcutaneous tunnel. Transposition and superficialization were followed by another injection of heparinized saline to dilate the vein. The absence of a twisting vein must be confirmed. The basilic vein and the brachial artery were anastomosed end-to-side. Thrill on the basilic vein and distal radial and ulnar pulses were evaluated. The wound was closed by two-layer suture. Figure 1 shows the anatomy of the upper arm during a basilic vein transposition.

This study created a brachio-axillary AVG using straight carbon-lined polytetrafluoroethylene (PTFE) graft with a 6 mm diameter and 15 cm length. The creation of AVG as tertiary vascular access has similar main steps to the procedure in the forearm. Briefly, the medial incision exposed the brachial artery proximal to the antecubital fossa and the axillary vein two cm below the axilla. The graft was then inserted into a subcutaneous tunnel in the anterior arm of the patient. The venous anastomosis was established first. After the procedure, the pulsatility of the graft was monitored. Figure 2 shows the anatomy of the upper arm with AVG.

**Case illustration**

A male, 68 years old, was diagnosed with stage V chronic kidney disease on routine hemodialysis for 5 years ago. The patient already had radio-cephalic and brachiocephalic fistula made in both hands. The previous radio-cephalic and brachiocephalic fistula in the right arm failed to mature. The patient had a history of central vein stenosis in the left arm 6 months ago and was currently using a catheter as hemodialysis access.

We performed a physical examination and Doppler ultrasonography for pre-operative evaluation and access planning. The patient opted for the creation of TBB-AVF. The surgery was performed under local anesthesia for 135 minutes. We transposed and superficialized the basilic vein and performed end-to-side anastomosis, as seen in Figure 3. Thrills were evaluated after the procedure. The patient complained of post-operative swelling in the right arm. The complaint was resolved after 1 week of being treated conservatively. The patient was followed up after 1 year of TBB-AVF creation and had routine hemodialysis without any complaint of fistula malfunction.

### Table 1. Demographic characteristics of patients.

<table>
<thead>
<tr>
<th>Variable</th>
<th>N (%)</th>
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<tbody>
<tr>
<td>Sex</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>10 (58.8)</td>
</tr>
<tr>
<td>Female</td>
<td>7 (41.2)</td>
</tr>
<tr>
<td>Age (y)</td>
<td></td>
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<tr>
<td>Mean</td>
<td>54.2</td>
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<tr>
<td>Range</td>
<td>24-76</td>
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<tr>
<td>Early Failure Rate</td>
<td></td>
</tr>
<tr>
<td>TBB-AVF</td>
<td>2 (14.3)</td>
</tr>
<tr>
<td>AVG</td>
<td>1 (11.1)</td>
</tr>
<tr>
<td>Patency in 6 months (%)</td>
<td></td>
</tr>
<tr>
<td>TBB-AVF</td>
<td>91.7</td>
</tr>
<tr>
<td>AVG</td>
<td>87.5</td>
</tr>
<tr>
<td>Patency in 1 year (%)</td>
<td></td>
</tr>
<tr>
<td>TBB-AVF</td>
<td>85.7</td>
</tr>
<tr>
<td>AVG</td>
<td>16.7</td>
</tr>
<tr>
<td>Death on follow up</td>
<td>1 (5.9)</td>
</tr>
<tr>
<td>Central vein stenosis</td>
<td>3 (17.7)</td>
</tr>
<tr>
<td>Pseudoaneurysm</td>
<td>1 (5.9)</td>
</tr>
</tbody>
</table>

The cumulative patency rate in six months was 91.7% for the TBB-AVF group and 87.5% for the AVG group. In contrast, the cumulative patency rate in one year was 85.7% for the TBB-AVF group and 16.7% for the AVG group.

### DISCUSSION

The results were in line with other studies. Serial cases by Basel et al. supported the superiority of TBB-AVF's patency over AVG. In their study, patency in two years was 67% for TBB-AVF and 32% for AVG. Similar results showed by Chue et al. in 2016, primary and secondary patency in one year were 73.2% and 71.8% for TBB-AVF, 34.1% and 54.3% for AVG. Some studies also showed that TBB-AVF had less risk of infections and thromboses. Infection rate of TBB-AVF was reported to be significantly lower (0.8%) compared to AVG (6.9%).

Despite studies showing that TBB-AVF had better functional patency than AVG, the procedure was associated with a higher failure rate, assuming it was more technically challenging. The procedure also needed a longer maturation time. Large incisions in the creation of TBB-AVF are also related to complications such as limb edema. TBB-AVF had a higher early failure rate than AVG in our study.

There are two approaches used to create TBB-AVF, one-staged and two-staged approaches. Which technique is superior remains controversial? Vrakas et al. reported that the two-staged approach had better primary (71% vs. 87%) and secondary (79% vs. 95%) patency in one year than the one-staged approach. Others reported that both approaches had similar patency but a higher complication rate in the one-staged approach, including thrombosis and hematoma. Systematic review and meta-analysis by Bashar et al. suggested that differences between the two approaches, including overall maturation...
rate and post-operative complication, were not statistically significant with comparable patency.\textsuperscript{13} Generally, two-staged procedures offered smaller incision size, higher maturation and patency rate, and lower failure rates but longer cannulation time.\textsuperscript{14,15}

Compared with AVG, TBB-AVF showed fewer long-term complications.\textsuperscript{16} However, Chue et al., suggested when other factors such as maturation time and early failure rate are taken into account, for the first 24 weeks, AVG as tertiary vascular access was superior.\textsuperscript{2} Our result also showed a comparable patency rate between TBB-AVF and AVG for the first 24 weeks. Furthermore, the complexity of TBB-AVF should be considered. Therefore, proponents of AVG have suggested that AVG can be preferred in patients with a limited life expectancy or in patients who were prone to develop tunneled central venous catheter complications.\textsuperscript{17}

Field et al. reported that age over 60 years and the presence of peripheral vascular disease were associated with worse outcomes in 140 patients with TBB-AVF.\textsuperscript{16} According to Drouven et al., prior catheter use and diabetes were significant predictors of primary patency in patients with TBB-AVF. At the same time, age and body mass index were significant predictors of primary patency in patients with AVG. Primary patency in TBB-AVF patients was assumed to be affected by catheter use due to the risk of outflow vessel injury.\textsuperscript{18}

We acknowledge our study had several limitations, including a retrospective study design, non-randomized and small sample size. A larger and prospective study is required to further compare the effectiveness of TBB-AVF and AVG as tertiary vascular access.

**CONCLUSION**

This study presents a case series of ESRD patients with tertiary vascular access. TBB-AVF should only be suggested if primary and secondary vascular access options have been exhausted. The TBB-AVF was more effective in terms of functional patency than AVG as tertiary vascular access. Graft vascular access was associated with more long-term complications. However, using AVG can be considered in certain conditions when TBB-AVF is impossible.

**CONFLICT OF INTEREST**

All authors declare no conflict of interest.

**FUNDING**

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

**ETHICS APPROVAL**

The Institutional Review Board of Prof. Ngeorah General Hospital has approved this study.

**CONSENT**

All patients in this study have understood and agreed to the use of patient personal data related to the writing of scientific articles. All patients gave informed consent consciously regarding using the data obtained to prepare papers to be published in scientific journals.

**AUTHOR CONTRIBUTIONS**

Conception and design: RS, INS; Analysis and interpretation: RS, INS; Data collection: RS, IWS, INS; Writing the article: RS; Critical revision of the article: IWS, INS; Final approval of the article*: RS, IWS, INS; Statistical analysis: RS; Overall responsibility: RS, INS.

**REFERENCES**