INTRODUCTION
The optimal treatment for end-stage renal failure is renal transplantation. Unfortunately, there is a serious lack of donor organs and a long waiting list for a kidney. Hemodialysis, therefore, becomes the only life-sustaining option for most of these patients. With improvement in dialysis technology, patients are surviving longer with a better quality of life.

The construction of a radiocephalic autogenous arteriovenous fistula (AVF) by Brescia and Cimino’s team in 1966 for dialysis access was a milestone. Autogenous AVFs are preferred over vascular prostheses in terms of their long-term patency and low complication rates. The 1-year patency of Brescia-Cimino fistulas is 90%, compared to 51% of polytetrafluoroethylene grafts.1 Undoubtedly, a distal AVF in the arm or hand with high blood flow facilitates dialysis, besides being easier to create. A distal snuff-box or radiocephalic fistula should be the first choice, while a proximal antecubital fistula is reserved for subsequent use.2

The patency of AVFs is affected by several factors. The first is the quality of the arterial system. Arterial stenosis due to arteriosclerosis or vasculitis may reduce arterial blood flow, while hypotension may decrease fistula patency. Physical examination using the Allen test and other methods is very useful in giving information about blood flow in the radial and ulnar arteries as well as perfusion of the hand. The second factor is the quality of the venous system. Venous punctures may cause thrombosis. In addition, subclavian vein catheterization for temporary dialysis access may cause central vein stenosis in up to 50% of cases.3 Percussion of the vein is a simple method for detecting vein occlusion. Doppler ultrasonography is non-invasive and is another widely used method. Other factors including anastomotic failure and coagulopathy affect early patency.

ABSTRACT
The early patency of arteriovenous fistulas created for hemodialysis is affected by various factors, including venous stenosis. We conducted a study to investigate the effect of venous stenosis on early patency by examining perioperative arterial and venous pressures of the fistula. Among the 15 patients selected for the study, 11 had snuff-box fistulas, 3 Brescia-Cimino, and 1 brachial. A thrill was palpable over the anastomosis in 10 patients and absent in 5 patients. In terms of venous pressure, the patients with a thrill had a mean systolic pressure of 35.8 mm Hg and systolic-diastolic pressure gradient of 3.4 mm Hg. In the patients without a thrill, the values were 102.6 mm Hg and 42.8 mm Hg, respectively. In conclusion, patients with venous obstruction in the fistula had a much higher venous pressure than those with a patent fistula. If venous stenosis is suspected, measurement of fistula pressures may be useful for determining the early patency of arteriovenous fistulas.

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2005, VOL. 13, NO. 2 131  ASIAN CARDIOVASCULAR & THORACIC ANNALS
Arteriovenous Fistula Pressure Analysis

Improper manipulation during insertion of arterial and venous catheters during dialysis affects late patency.

In this study, we investigated perioperative arterial and venous pressures in functioning and nonfunctioning AVFs to determine if they reflect fistula patency.

**PATIENTS AND METHODS**

A total of 15 patients, 10 male and 5 female, were selected for this study. Informed consent was obtained. The patients were aged between 46 and 70 years (mean, 62 years). All of them had end-stage renal disease resulting from chronic glomerulonephritis, with diuresis of 300 to 1,000 mL·day⁻¹ (mean, 600 mL·day⁻¹). They required hemodialysis 3 times a week. None of them were diabetic. The Allen test revealed no arterial perfusion problems. Percussion of the vein showed no venous occlusion or thrombophlebitis.

A snuff-box fistula was created in 11 of the patients, a Brescia-Cimino fistula in 3, and a brachial fistula in 1. The same surgeon constructed all the fistulas by end-of-vein to side-of-artery anastomosis using 6/0 polypropylene suture with an 8 mm needle.

After completion of the anastomosis and closure of the incision, the patient was palpated for a thrill over the fistula. A puncture was then made with a 24-gauge cannula on the distal side of the anastomosis to measure distal arterial pressure. The cannula was then advanced through the anastomosis to the proximal side to measure proximal arterial pressure. These 2 pressures were compared to determine if there was anastomotic failure. Finally, another puncture was made to the vein with the same cannula at least 2 cm away from the anastomosis to measure venous pressure.

**RESULTS**

Perioperatively, 10 patients had a thrill and 5 did not. The proximal arterial and the venous pressures of the patients are shown in Table 1. The mean systolic venous pressure in the patients without a thrill was 102.6 mm Hg (range, 56 to 134 mm Hg), which was much higher than the mean value of 35.8 mm Hg (range, 25 to 51 mm Hg) in those with a thrill (Figure 1A).

There should be a pressure gradient between the arterial and the venous systems to create a thrill. The systolic arterial-venous pressure gradient in the patients with a thrill was considerably higher (mean, 133.6 mm Hg; range, 106 to 177 mm Hg) than in those without a thrill (mean, 48.2 mm Hg; range, 8 to 101 mm Hg) (Figure 1B).

In terms of the systolic-diastolic pressure gradient of the venous system, it was much lower in the patients with a thrill (mean, 3.4 mm Hg; range 0 to 5 mm Hg) than in those without a thrill (mean, 42.8 mm Hg; range, 31 to 64 mm Hg) (Figure 1C).

Finally, the ratios of venous to arterial systolic pressure ranged from 0.14 to 0.32 in the patients with a thrill and from 0.36 to 0.94 in those without a thrill (Figure 1D).

**DISCUSSION**

We conclude from the results that the AVF of patients without a thrill had a high venous pressure caused...
by venous obstruction. In the presence of venous stenosis, AVF runoff is obstructed. Consequently, the high pressure in the arterial system does not fall when blood reaches the venous system. Hence, venous pressure rises, reducing the arterial-venous pressure gradient. In addition, the flow pattern in the venous system becomes pulsatile, as in the arterial system. As a result, a large amount of blood passes through the anastomosis in the high-pressure systole, but the flow decreases in the low-pressure diastole. Thus, the venous systolic-diastolic pressure gradient increases and only pulsation can be felt over the fistula. In contrast, this gradient is small in patients with a good venous runoff because blood passes from the arterial to the venous system in a systolic-diastolic continuity.

Venous pressure has been reported to elevate in the presence of venous stenosis, and intra-access pressure shown to relate to venous outlet stenosis. In a study examining the effects of stricture and venous outlet stenosis in vascular accesses on access flow, stricture was found not to affect access flow, while stenosis reduced flow and raised venous pressure. The degree of venous stenosis was evaluated by ultrasonography and fistulography. Strictures are adventitial fibrotic bands that partially constrict the vein from the outside. In our study, all venous strictures that were close to the anastomosis were removed. Besarab and colleagues reported venous-arterial pressure ratios of 0.34 or lower in patients with a thrill, while in our study this ratio was not above 0.32 in the patients with a thrill but was at least 0.36 in those without.

Monitoring pressure continuously and directly through the fistula, Nakane and colleagues observed that intrafistula pressure paralleled systemic arterial pressure during hemodialysis. In 5 patients who often showed symptomatic hypotension during dialysis, they successfully prevented hypotension and maintained fistula patency by infusing 50 mL of saline intravenously when intrafistula pressure fell to 60% of the level at the start of dialysis. Köksoy and associates found Doppler ultrasonography performed pre- and postoperatively useful in predicting the development of thrombosis in polytetrafluoroethylene vascular access grafts. Van Stone and co-workers observed higher dialysis access pressures during hemodialysis in patients with venous stenosis. Furthermore, this access pressure correlated with systemic arterial pressure and venous pressure.

If, immediately after construction, a fistula produces only pulsation but no thrill, a decision has to be made whether to wait a few days to see if it will improve or to ligate it and create another fistula. A parameter that can be determined perioperatively for predicting the survival of the fistula would be very useful in helping the surgeon to decide.
this study, arterial and venous pressures of the fistula were measured after its construction. From the results, we suggest that if a pulse but not a thrill is present and the venous-arterial pressure ratio is above 0.36, an obstruction in the proximal venous system should be suspected. If a thrill is present, the ratio should not exceed 0.36. Finally, the absence of both a thrill and a pulse may suggest anastomotic failure or early thrombosis.

REFERENCES