

Single - Needle Dialysis

H. Ray Panter,
K. F. Kopp,
C. F. Gutch,
D. van Dura

Introduction

Access to the bloodstream has always been a problem in hemodialysis. The presently preferred method is a surgically created arteriovenous fistula, as described by Brescia and co-workers in 1966. However, the use of the A-V fistula is limited. Frequent venipunctures with large bore cannulae are painful, require skill to insert, and are detrimental to the fistula vessels. A method is described using a single needle instead of two + in order to connect the patient to the artificial kidney.

Objective

A method of "single needle" dialysis was designed by Dr. K. F. Kopp and the first clinical trials were begun at the University of Utah in February, 1971. With Dr. Kopp's method, enough blood can be obtained for efficient hemodialysis using a single one lumen cannula of the usual size. The blood flows alternately in and out, at regular intervals, through the same cannula. The cannula is connected to the arterial and venous lines of the dialyzer by a "Y" connector. (Figure 1) The blood lines are alternately occluded by the use of a solenoid clamp before the blood pump and after the venous drip chamber. (Figure 2) The result is a pulsatile, unidirectional blood flow through the dialyzer and cannula. The clamps are controlled by a pressure monitor and time delay device connected to the drip chamber.

There is a certain amount of recirculated blood due to back-mixing. However, this amount has been determined to rarely exceed 20% of the total flow which is passed through the dialyzer. The recirculated volume does not seem to increase the dialysis time.

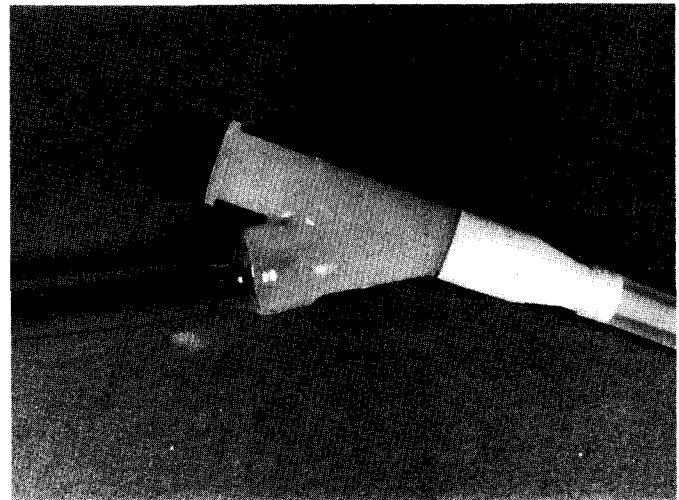
Method

The operation of the machine is in two distinct modes.

Mode A—The afferent blood going into the kidney.

Mode B—The efferent blood going into the patient.

Afferent Mode A The arterial clamp is opened and the venous clamp is closed (Figure 3) until the drip chamber pressure reaches the preset level of the monitor, at which time the time delay holds the venous clamp closed for an interval from 0.5 to 1.5 seconds. The pressure in the drip chamber continues to rise until the time delay is over. At this time, the venous clamp opens and the arterial clamp closes.



From Home Dialysis Training Center
Division of Artificial Organs
University of Utah
Salt Lake City, Utah 84112

Figure 1—"Y" connector

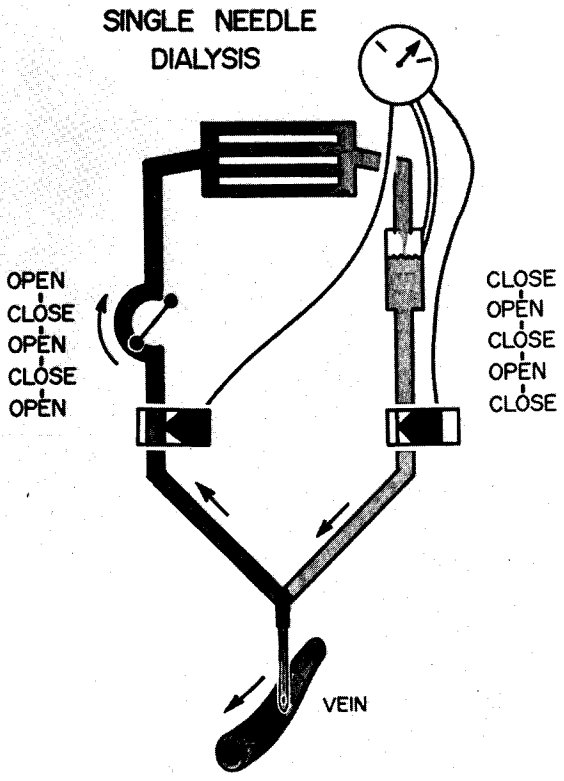


Figure 2: Schematic

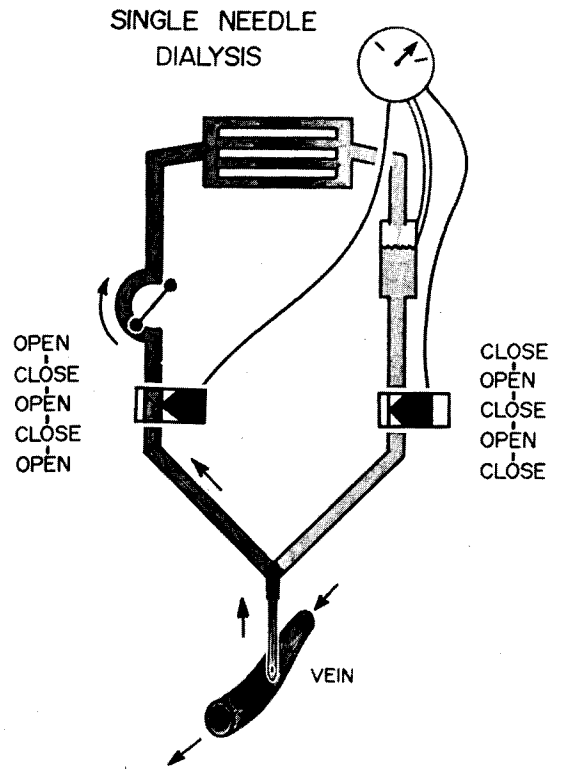


Figure 3: Mode A

Efferent Mode B (Figure 4) The alternating of the clamps enables the blood to return to the drip chamber, creating a decreased pressure in the drip chamber. The monitor indicator then returns to the preset limit to start the cycle over again.

The blood pump turns continuously and creates a negative pressure in the arterial line during the 0.5 to 1.5 seconds time delay when the arterial line is occluded. This necessitates a more efficient blood flow from the patient. This was accomplished with the use of a teflon angiocath 13 gauge x 1 1/4" or a 14 gauge x 1" needle with two side holes developed at the Dialysis Center and which is manufactured by the Deseret Pharmaceutical Company of Sandy, Utah (Figure 5 and 6).

To cannulate the fistula, a catheter is inserted in the vessel in the direction of blood flow (Figure 7). This allows the arterial flow in the patient to carry the dialyzed blood away from the catheter tip.

A number of successful single needle dialysis by femoral vein cannulations have been made (Figure 8). The use of a 2" 14 gauge angiocath with two side holes eliminates the need for the Seldinger femoral cannulation technique.

The monitoring of blood chemistries has been done on a comparative basis since we have a certain amount of re-circulated volume and cannot be positive of the arterial concentration. A predialysis blood sample is taken for BUN, creatinine, and uric acid determinations. These results are

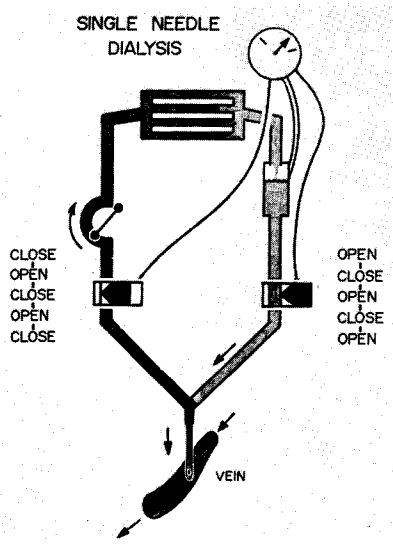


Figure 4: Mode B

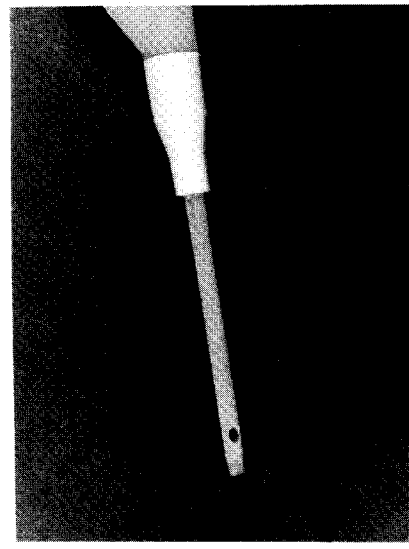
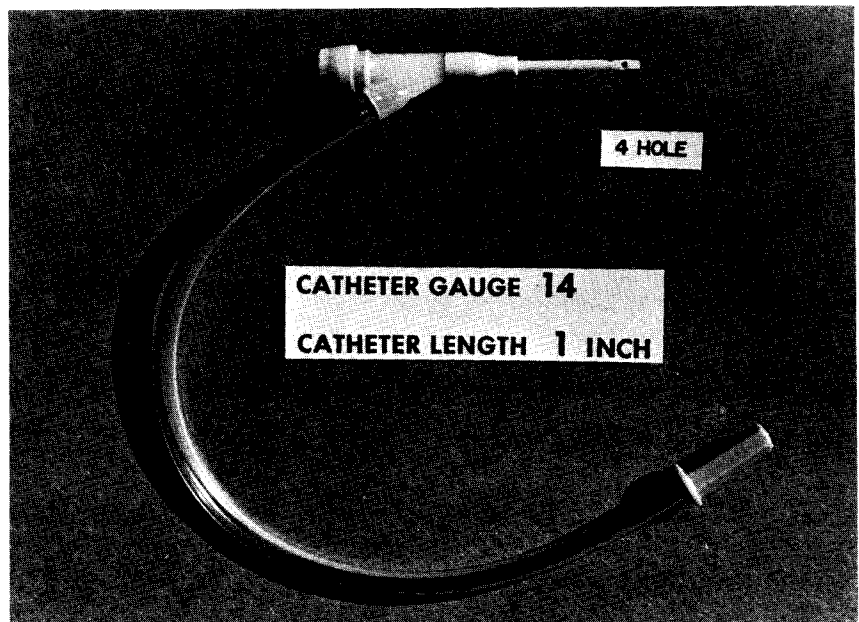


Figure 5: 13ga. Side Hole Catheter

Figure 6
Side Hole
Catheter
and
"Y" Apparatus



compared with the patient's previous predialysis values utilizing the A-V shunt or 2 cannulae insertion technique, and the difference has been insignificant.

We have found that both the patient and the instructor are receptive to this method of treatment for the following reasons:

- 1) The patient usually receives only one insertion of the cannula.
- 2) The cosmetic appearance of the arm improves with decreased number of venipunctures.
- 3) The patient or instructor does not have to adjust and read just the venous filtration pressure, but merely sets the pressure and it automatically adjusts itself to the new pressure desired.
- 4) The solenoid clamps will run irregularly if there is poor exchange at the catheter tip. The distinct click of the solenoid is interrupted, and the patient or instructor will investigate and correct the problem.

Conclusion

In conclusion, I would like to mention an example of a patient, presently at home, on the Home Training Program. Mrs. Y weighs 156 lbs. with a blood pressure of 120/80 and a pulse 80-90 per minute.

This patient was first dialyzed with a Scribner arm shunt which lasted two months, at which time it clotted and was removed. Due to a lack of suitable veins in the opposite arm, a shunt in the leg was attempted. The surgeons encountered fibrotic tissue in both legs, and therefore, constructed an arterio-venous fistula in the lower right arm. It was necessary to wait three weeks for the fistula to mature, and during that time, she was maintained with femoral vein cannulations. The patient then resumed her training and went home after 6 weeks on the single needle system.

Her fistula is being very successfully cannulated by her husband. Without this method of dialysis for this patient, it would be very difficult to get accessibility to her blood supply. This is not an extreme case; many patients lose access sites to their blood supply due to shunt problems, and it may not be too many months before they have no shunt insertion sites left. However, if we could install an arterio-venous fistula in an arm with limited surface vessels, these patients could very easily be dialyzed utilizing a single needle system.

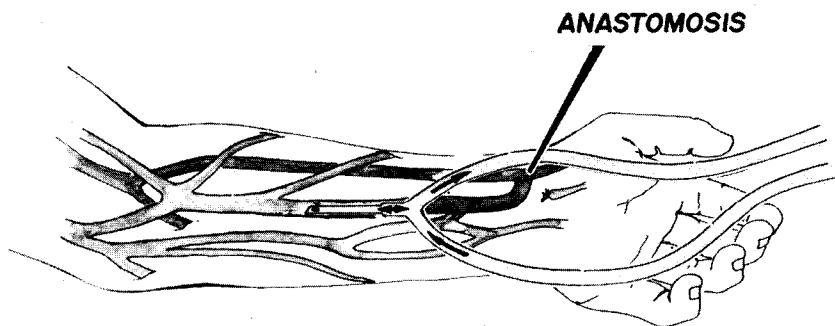


Figure 7:
Catheter in
Position
on
Fistula

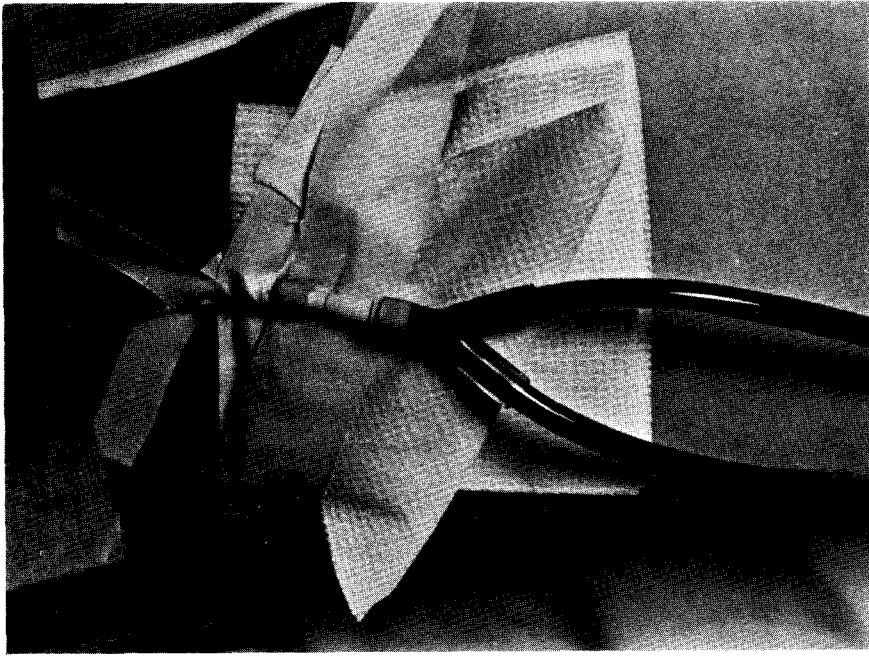


Figure 8:
Femoral
Vein
Cannulation

SUMMARY

The single needle, one lumen hemodialyzing device has been shown in some instances to have advantages over the standard dialyzing system and be equivalent to it in others. Some interesting features of the device are, its ability to be used with any dialyzer system which utilizes a blood pump. It has been tried successfully on the Kolff Coil Kidney,* the Cordis-Dow Hollow Fiber Kidney, and the E-Z-S Plate Kidney** systems. The efficiency of dialysis has been shown to equal that of the standard system with no increase in the dialysis length. The safety features of the

device include an automatic venous pressure monitor controlling both high and low pressure and an audible blood exchange monitor. The most important feature of the device is that of only one cannulation which decreases patient discomfort, decreases hookup time, and aids the cosmetic appearance of the patient's arm.

*Manufactured as Travenol twin coil, and Extracorporeal EX-03 coil.

**Machine developed by Vital Assists, Inc. 30 Kensington Avenue, Salt Lake City, Utah.

