SIMPLE TECHNIQUE FOR RAPID BOLUS INJECTION

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The successful use of the gamma camera for dynamic vascular studies depends on the rapid delivery of a concentrated bolus of radionuclide to the area of interest. Oldendorf (*1*) and Ashburn (*2*) have described methods of bolus delivery with intravenous injection. We wish to present an effective and simple technique using materials likely to be on hand and adaptable to patients in any position.

Referring to Fig. 1: The syringe containing radionuclide is kept in a shielded container until the system is ready for the bolus delivery. If a large vein is accessible, it is entered with an 18-gage needle and good back-flow through the connecting tubing is attained. The tourniquet is then removed. Immobility of the arm and needle must be maintained since a laceration of the venous wall by the needle bevel is possible and will result in massive extravasation on injection. (If the veins are small or difficult to cannulate, a 19-gage scalp vein infusion set with 18-gage bore may be substituted for the straight 18-gage needle. This alteration increases delivery time but is still acceptable.) The syringe containing radionuclide is attached to the three-way stopcock, and the radionuclide is injected backwards into the connecting tubing so that it will be leading the bolus. The connecting tubing should be cleared of blood before filling with radionuclide to prevent possible formation of "hot clots" which might adhere to venous valves when injected. A saline flush of 25–30 cc propels the bolus and minimizes the "tail effect". The radiation dose to the hands is about 25 mrads with 10 sec of handling, and the dose to parts of the body 10 cm away from the syringe is less than 1 mrad.

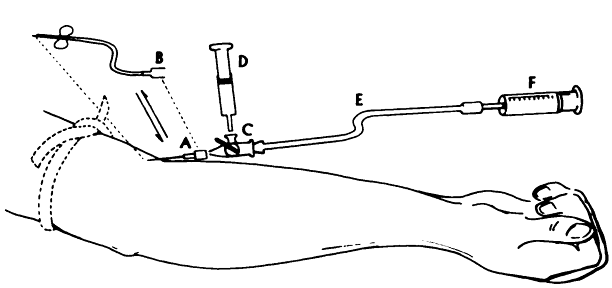

FIG. 1. Bolus delivery system. A, 18-gage needle; B, 19-gage scalp infusion set as alternate to A; C, three-way stopcock; D, syringe containing radionuclide; E, connecting tubing; F, syringe containing 20–30 cc saline. To use system, fill ACE with saline, enter vein, remove tourniquet, clear line, turn stopcock handle to A, attach syringe containing radionuclide at D, empty it into E, turn stopcock handle to D, inject rapidly from F.

The technique satisfies the requirements of speed, flexibility, adaptability, minimal exposure to unshielded radionuclide, control over injection rate, and simplicity. It does not completely overcome the problem of thoracic inlet resistance which often causes the bolus to decelerate near the junction of the subclavian and jugular veins. This problem would be overcome by injection through a central venous pressure catheter as has been suggested by Ashburn (*2*) or through an intravenous NIH catheter as has been suggested by Zimmerman (*3*). Extending the arm prior to injection and asking the patient to inspire slowly during injection may help minimize thoracic inlet resistance.

To evaluate the effectiveness of the new bolus delivery technique as compared to conventional injection, curves of activity as a function of time were made for the passage of bolus through the right ventricle using a digital image analysis system (Intertechnique). Boluses obtained from the conventional and the new techniques were compared using the half width at half maximum for the leading and trailing portions of the curve as illustrated in Fig. 2. The leading half width at half maximum (LHWHM) is a measure of the sharpness of arrival time, and the trailing half width at half maximum (THWHM) is

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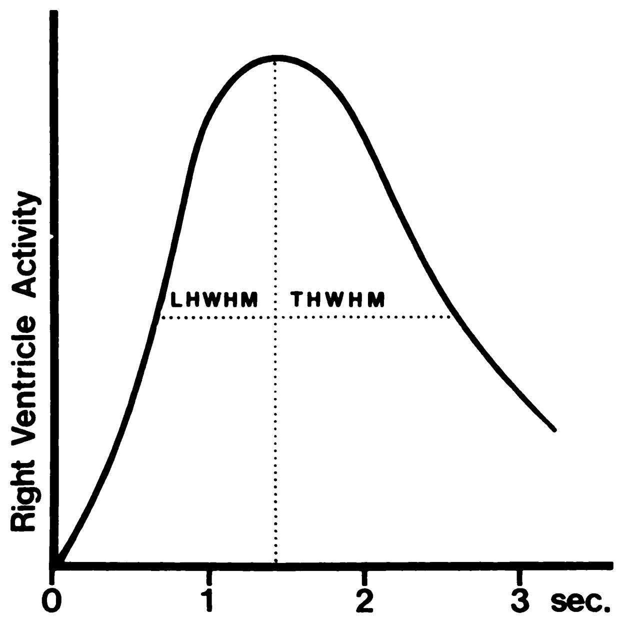

FIG. 2. Parameters of bolus delivery. LHW (leading half width at half maximum) is measure of rapidity of bolus delivery; THW (trailing half width at half maximum) is measure of "tail effect". Full width at half maximum (FWHM) is sum of two terms.

a measure of the tail of the bolus activity which should be minimized by the saline flush. Table 1 shows the analysis of 15 cases, four using simple, rapid injections through a syringe and 20-gage needle, and 11 using the new system.

The results support the conclusion that the new bolus injection technique delivers the radionuclide at a significantly faster rate ($p = 0.02$ for leading edge, $p = 0.01$ for trailing edge). The system described is simple to use, requires materials likely to be on hand, and delivers a bolus of radionuclide rapidly and cleanly with little radiation exposure. The cost of the additional materials needed is less than $1, and the additional time required to set up the system is less than 1 minute.

TABLE 1. ANALYSIS OF 15 CURVES COMPARING CONVENTIONAL AND NEW TECHNIQUES

	Conventional technique (4 cases)		New technique (11 cases)		
	mean (sec)	s.d. (sec)	mean (sec)	s.d. (sec)	P*
Leading half width at half maximum (LHWHM)	3.08	1.58	1.15	0.44	0.02
Trailing half width at half maximum (THWHM)	5.53	2.42	2.26	1.26	0.01
Full width at half maximum (FWHM)	8.60	3.83	3.42	1.64	0.01

* P = probability that means represent the same population.

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