

Evaluation of a Simple Technique for Abrupt Intravenous Injection of Radioisotope¹

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Several techniques for hemodynamic evaluation require an abrupt intravenous injection of a labeled compound. This approach has been used in external monitoring techniques for measuring cardiac output, in attempts to measure coronary blood flow and in several techniques for assessing cerebral circulation. The following abrupt injection technique deposits labeled material as rapidly as possible into the right heart, so that subsequent streaming of tracer by cardiopulmonary passage is minimized. It is the purpose of this report to describe the technique and to present an evaluation of its capability to rapidly deliver tracer into the right heart more abruptly than simple rapid intravenous injection.

Technique: This technique is shown diagrammatically in Fig. 1. It has been described in part previously (1). The subject's arm is positioned on a slightly elevated armboard with the elbow slightly flexed. The arm is supported only at the elbow and one finger (Fig. 2). The upper part of the arm is held free above the mattress supporting the patient. A "Velcro"³ blood pressure cuff is placed on the upper arm and inflated to about 100 mm of mercury, provided that this is below the systolic brachial arterial pressure. The cuff is left in place for one minute, causing a distention of the venous pool in the distal arm and a rise in the venous blood pressure in the distal arm to exceed the cuff pressure. A 25-gauge, 1 inch needle for subsequent injection is placed in a deep antecubital vein. The cuff pressure is further increased until it substantially exceeds the systolic pressure. The circulation in the distal arm is thus cut off with the venous pool still in a distended condition.

With the arm circulation thus interrupted, the tracer is injected into the antecubital vein. The rate of injection need not be rapid, since the circulation is completely interrupted by the inflated cuff. Up to about 3 ml of solution can be injected in this way without causing significant extravasation, but our usual technique utilizes only 1 ml of saline.

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³Available from the Taylor Instrument Co., Rochester, New York.

After the injection has been completed, the cuff is removed abruptly while fully inflated. The needle is removed 1 to 2 seconds later. No pressure is applied to the injection site since this might impair venous drainage. The collapsing venous pool accelerates delivery of the bolus of injected isotope to the right heart. After the isotope is in the vein, removal of the cuff can be delayed for periods as long as one minute to permit final preparation of detection equipment. The tracer does not leave the distal arm until the cuff is released.

Evaluation: To evaluate an earlier impression that this method of injection produced a more dependably abrupt deposition of isotope into the right heart than a simple rapid injection through a large needle, ten subjects were studied using the abrupt cuff-release technique. On a subsequent day each subject was restudied using a simple rapid injection on the same armboard using a 20-gauge needle. In this latter series, the labeled material was entirely deposited within the antecubital vein within one-half second.

Fifty microcuries of sodium orthoiodo ^{131}I hippurate (Hippurate, Squibb) was the activity dosage used for each subject. The total cranial content was monitored by a total cranial detection system which has been described (2). The appearance of the radioisotope in the head and its subsequent passage

TECHNIQUE FOR BOLUS PRODUCTION BY ANTECUBITAL INTRAVENOUS INJECTION

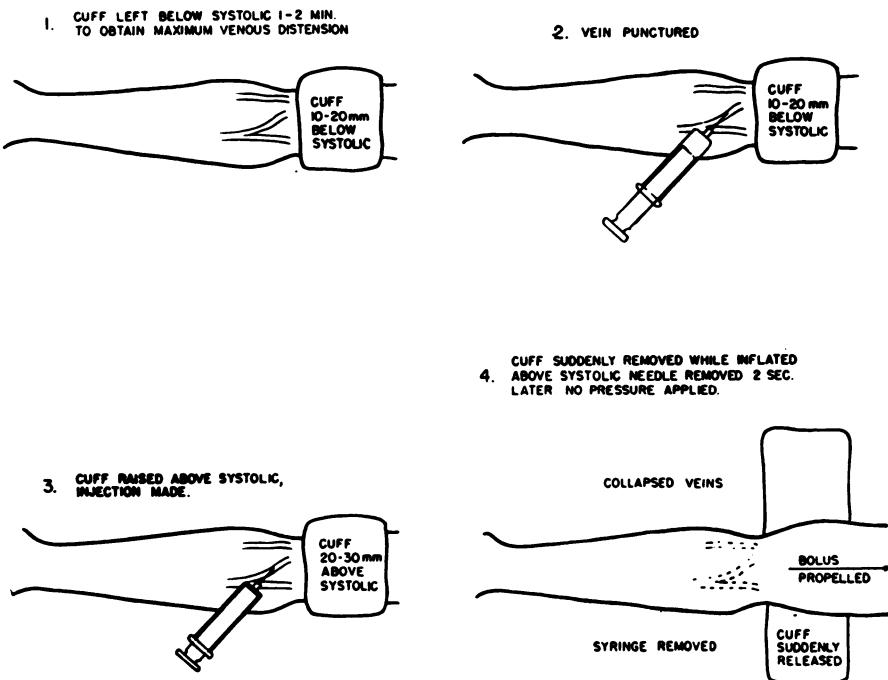


Fig. 1. Steps in the performance of the cuff release technique.

through the cranial blood pool were recorded by plotting the count rate as a function of time.

The two curves shown in Fig. 3 represent the results on ten normal adult male subjects studied by the abrupt cuff-release technique and later restudied by simple rapid injection. To obtain each curve, the tape recordings for each technique were counted using a one second interval with a digital print-out. Time zero is at the time of abrupt cuff release in the cuff-release series, and at the time of deposition in the vein in the simple rapid injection series. The curves derived from each series of ten tests were averaged by adding all counts from the corresponding one second intervals after time zero.

The curves shown in Fig. 3 indicate that the arrival in the head derived from the averaged curve using the abrupt cuff-release technique commences earlier, indicating a shorter arm to head circulation time. The head count rises to a higher, sharper peak and falls off more rapidly using the abrupt cuff-release technique. To determine whether the two groups were significantly different, conventional challenge of the two-group separation was done by the "t" test, with 19 degrees of freedom, using each patient as his own control. This test showed separation significant to the .01 level.

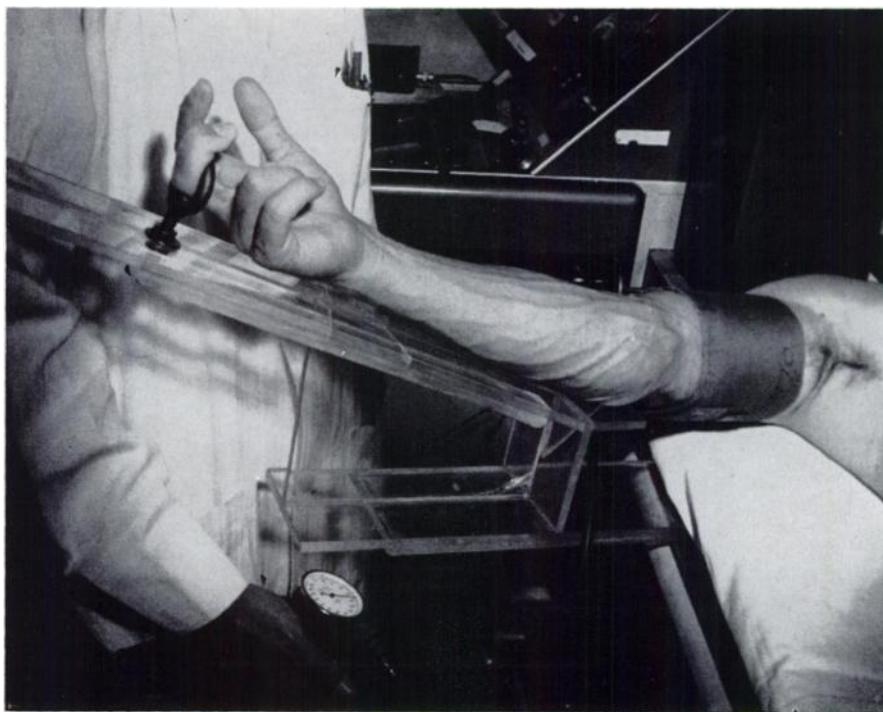


Fig. 2. The arm is held in a slightly elevated, flexed position and contact with the armboard is only at the elbow and finger. A free space is provided beneath the upper arm for the blood pressure cuff to fall completely free of the arm. Care is taken not to compress the injection site immediately after withdrawal of the needle.

DISCUSSION

This method is considered to result in a more dependable abrupt deposition of intravenously injected tracer into the right heart. It has the clinical advantage of allowing a venipuncture using an extremely small needle. Since the rate of injection is not critical, a needle as small as can dependably be placed in a vein can be used. This results in a reduction of patient discomfort. The slow rate of injection employed minimizes the possibility that tracer will be spilled during the injection period with resulting loss of isotope and room contamination. The entire technique is attended by little discomfort to the patient.

The shorter arm-to-head circulation time in the abrupt cuff-release technique presumably reflects the pressure high in the distal venous pool, which positively propels the bolus toward the right heart. The pressure differential across the

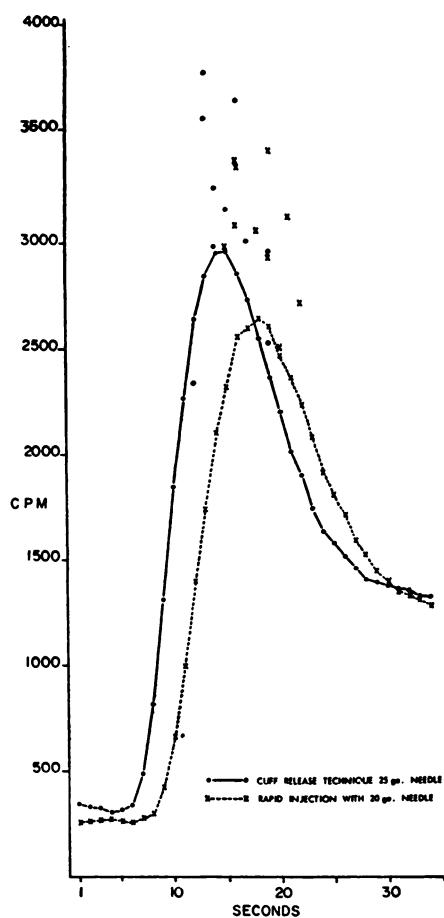


Fig. 3. Average curves of head count resulting from a study of ten subjects using simple abrupt cuff release technique and restudied using a larger needle with simple rapid injection. The difference between these curves presumably represents the rapidity with which the material is transported from the antecubital injection site into the right atrium. The isolated points represent peaks of the individual twenty curves.

cuff compression site and the adjacent injection site immediately after cuff release is of the order of 100 mm Hg or more in the abrupt cuff-release technique, and is no more than a few mm Hg in the simple rapid injection technique. The pressure differential acts in the manner of a storage-type water closet; the elevated stored water is analogous to the trapped, distended venous pool, and the abrupt cuff release corresponds to the initiation of flushing.

Relative to other techniques attempting to accomplish a rapid deposition into the right heart, this technique is simple and does not require high elevation of the arm or stopcock switching to flush in saline. The evaluation of saline flushing by Bousvaros *et al* (3) indicates this method is demonstrably superior to simple injection, but it produces a less compact bolus than injection into a centrally placed venous catheter. The cuff-release technique is suggested for testing situations where a very simple abrupt intravenous injection is desired.

It should be noted that the abrupt cuff-release technique is made feasible by the commercial availability of the Velcro cuff. Conventionally fastened cuffs do not permit a sufficiently abrupt decompression, as release of pressure takes place through the inflating tubes. The Velcro cuff is not decompressed, but actually removed abruptly from the arm. Its design makes it possible to remove it, and hence the occluding pressure, in a small fraction of a second.

SUMMARY

A simple,atraumatic technique of intravenous injection is described, which effects a dependably rapid deposition of isotope into the right heart. Venous distention is caused in the arm distal to a partially inflated cuff. A small needle is placed in an antecubital vein and the cuff pressure raised above systolic. Tracer is injected into the isolated venous pool. Abrupt release into the right heart is produced by sudden removal of the constricting cuff while still inflated.

Averaged results on ten normal adult males subjects studied by this simple abrupt injection technique and later by simple rapid injection are compared using isotope passage through the cranial blood pool as the indicator of bolus compactness. The abrupt cuff-release method was shown to produce a more compact bolus than simple rapid injection. A total cranial detection system showed a head count which rises to a higher, sharper peak and falls off more rapidly.

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