Comparison of Four 1-mL Syringes for Administering First-Pass Radionuclide Angiography Doses

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Objective: For optimal imaging in first-pass radionuclide angiography (FPRNA) studies, 1.11 GBq (30 mCi) ^{99m}Tc-sestamibi doses are drawn up in volumes of 0.1–0.3 mL. A single bolus injection of this small volume is important to obtain accurate time-activity curves. Because of the small volume and concentrated radioactivity, it is undesirable for study effectiveness and image quality to have a significant amount of residual activity remaining in the syringe after injection. The purpose of this study was to compare the amount of residual activity in 4 different 1-mL syringes.

Methods: Each test syringe (n = 20) was filled with a volume (0.2 mL) of ~1.11 GBq (~30 mCi) ^{99m}Tc-sestamibi. Initial activity was measured, and the dose was injected back into a vial only once, simulating bolus injection into a patient. The remaining activity was measured, followed by the calculation of percent residual activity.

Results: The two 25-G × 5/8-in. permanent needles had a low percent of residual activity, as well as a much sturdier needle for injection. However, one of these syringes is more expensive.

Conclusion: The results of our comparison studies showed that the syringe with a 25-G × 5/8-in. permanent needle is ideal for FPRNA doses because of its sturdiness, low residual activity, and the quality of the bolus and resulting images.

Key Words: syringe comparison; first-pass radionuclide angiography; bolus injection; technetium-99m-sestamibi; ejection fraction of the left ventricle; left ventricular regional wall motion

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A first-pass radionuclide angiography (FPRNA) can be performed in conjunction with a rest or stress myocardial perfusion study using ^{99m}Tc-sestamibi (*1–3*). An FPRNA study can be used to measure the ejection fraction of the left ventricle (LVEF) and to evaluate left ventricular regional wall motion (*2–4*). The successful FPRNA study depends heavily on the delivery of a compact bolus of highly concentrated radioactivity to the left ventricle (*2–6*). Because of the highly concentrated activity of the injected bolus (i.e., 1.11 GBq [30 mCi] ^{99m}Tc-sestamibi in a volume of 0.2 mL or less) (*1,7*), extremely high counting rates (150–400 kcps) can be achieved to provide statistically reliable data for the calculation of LVEF (*7,8*).

A 1-mL syringe usually is used for the dose injection because of the small volume injected for the FPRNA procedure. To maintain a bolus injection, the first-pass ^{99m}Tc-sestamibi dose is injected into an intravenous port and quickly followed with a physiological saline (i.e., 0.9% NaCl solution) flush (*3,7,8*). A dynamic computer acquisition is performed during this injection. However, this injection procedure can lead to high amounts of residual activity inside the syringe, which is undesirable for study effectiveness and image quality.

The purpose of this study was to compare the amount of the residual activity in 4 different 1-mL syringes so that an appropriate syringe could be selected for the bolus injection of myocardial first-pass doses.

MATERIALS AND METHODS

Types of Evaluated Syringes

Four different 1-mL syringes were used in our evaluation: (a) Monoject tuberculin syringe with 27-G × 1/2-in. detachable needle (Sherwood Medical, St. Louis, MO); (b) Monoject insulin syringe with 28-G × 1/2-in. permanent needle (Sherwood Medical, St. Louis, MO); (c) Monoject tuberculin syringe with 25-G × 5/8-in. permanent needle (Sherwood Medical, St. Louis, MO); and (d) B-D MedSaver syringe with 25-G × 5/8-in. permanent needle (Becton Dickinson and Co., Franklin Lakes, NJ). The outside diameters for the various needle gauge (G) numbers are listed in Table 1. The larger the gauge number, the smaller the size of the syringe needle.

Measurements of Residual Activity

Twenty ^{99m}Tc-sestamibi first-pass doses were drawn up in each of 4 different types of syringes. All doses contained similar amounts of radioactivity (i.e., 1,110 MBq [~30 mCi]) and volumes (i.e., ~0.2 mL). The initial activity and volume in each syringe were measured in a dose calibrator, and the doses were administered in a simulated bolus injection procedure by

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TABLE 1
Outside Diameters of Various Needle Gauges

Gauge (G)	Outside diameter (in. [mm])
28	0.014 (0.36)
27	0.016 (0.41)
26	0.020 (0.46)
25	0.022 (0.51)

injecting the ^{99m}Tc-sestamibi dose into a vial only once. The remaining activity in the syringe was measured, and the percent of residual activity was calculated using the following equation:

$$\text{Residual activity (\%)} = \frac{\text{Residual activity (MBq[mCi])}}{\text{Initial activity (MBq[mCi])}} \times 100.$$

Evaluation of Image Quality

The first-pass patient studies (N = 20) were performed with the injection of ~ 1,110 MBq (~30 mCi) in ~0.2 mL ^{99m}Tc-sestamibi using each of the 4 different types of 1-mL syringes. The image quality of the first-pass scans was compared among the 4 groups of patient studies (i.e., one type of 1-mL syringe per group; for each group N = 20).

RESULTS AND DISCUSSION

Monoject Tuberculin Syringe (27-G)

For optimal imaging in myocardial FPRNA studies, ^{99m}Tc-sestamibi doses usually are drawn up with a standard activity of 1,110 MBq (30 mCi) in a volume of 0.2 mL or less. Initially we used a Monoject 1-mL tuberculin syringe with 27-G × 1/2-in. detachable needle for administering the first-pass dose. The Monoject tuberculin syringe, equipped with a hub where a detachable needle is attached, is commonly available in the nuclear medicine/nuclear pharmacy laboratory for use when a point source is needed or during radiochemical purity evaluation. When administering first-pass doses, our nuclear cardiology technologist found that poor-quality images were resulting, despite good bolus injection technique. Because of the small volume of the dose and the required bolus injection, we suspected that not all of the ^{99m}Tc-sestamibi activity was being injected into the patient. We discovered that the 1-mL tuberculin syringe with the 27-G × 1/2-in. detachable needle by Monoject showed a residual activity of 17.6% ± 1.8% (n = 20) (Table 2). This was primarily due to the space in the hub of the syringe which retained a relatively large volume (~0.05 mL) of the dose after injection. The measured ^{99m}Tc-sestamibi activity retained in the hub of the Monoject tuberculin syringe with a 27-G × 1/2-in. detachable needle was determined to be 196.1 MBq ± 18.5 MBq (5.3 mCi ± 0.5 mCi) (n = 20), which could affect the imaging quality of SPECT cardiac studies, especially in obese patients.

Monoject Insulin Syringe

After seeing these results, we substituted a Monoject 1-mL insulin syringe with a permanently attached 28-G × 1/2-in. needle. We analyzed the retained activity of 20 doses with this type of syringe. The residual activity was 1.2% ± 0.4% (Table 2) with this syringe, a decreased amount compared to the syringe with the detachable needle. The Monoject insulin syringe with the 28-G × 1/2-in. permanent needle had the smallest percent of residual activity among the 4 different types of 1-mL syringes that we evaluated (Table 2). Image quality with the Monoject insulin syringe for the FPRNA study was significantly improved. However, the small needle size and flimsy nature of the 28-G needle led to needle bending, which could cause problems such as inability to inject, radioactive contamination to the patient and the imaging area, and employee needle sticks.

Monoject Tuberculin Syringe (25-G) and B-D MedSaver Syringe

The Monoject and B-D 1-mL syringes with 25-G × 5/8-in. permanent needles had a percent of residual activity at 1.9% ± 0.3% and 1.8% ± 0.6%, respectively (n = 20) (Table 2). Although the retained radioactivities, using both the Monoject and the B-D 1-mL syringes with 25-G × 5/8-in. permanent needles, were slightly more than the residual activity with the Monoject insulin syringe (Table 2), the percentages of residual activities were within an acceptable range. In addition, both the Monoject and the B-D 1-mL syringes with 25-G × 5/8-in. permanent needle had the advantages of a much sturdier needle for injection, as well as a slightly longer needle (5/8-in. longer when compared to the other 2 types of syringes), which allowed easier injections. The larger needle gauge with the Monoject and the B-D 1-mL syringes (25-G versus 27-G and 28-G) (Table 1) also enhanced the rapid delivery of the bolus dose.

However, the B-D MedSaver 1-mL syringe is the most expensive among the 4 types of syringes that we evaluated and costs twice as much as the Monoject tuberculin syringe with the 25-G × 5/8-in. permanent needle (Table 2). Thus, we selected the Monoject 1-mL tuberculin syringe with 25-G × 5/8-in. permanent needle as the syringe to be used for routine radiopharmaceutical administration for FPRNA studies. Subsequent use of this type of syringe has proven to be ideal for myocardial first-pass patient studies due to its sturdiness during

TABLE 2
Comparison of Four 1-ml Syringes for Injecting Myocardial First-Pass Doses (n = 20)

Type of syringe	Reorder number	Residual activity (%)	Price ratio
Monoject*			
Tuberculin syringe (27-G × ½-in.)	501386	17.6 ± 1.8	0.7
Insulin syringe (28-G × ½-in.)	501210	1.2 ± 0.4	0.9
Tuberculin syringe (25-G × ⅝-in.)	501640	1.9 ± 0.3	1.0
B-D†			
MedSaver syringe (25-G × ⅝-in.)	305605	1.8 ± 0.6	2.0

*Sherwood Medical, St. Louis, MO.

†Becton Dickinson and Co., Franklin Lakes, NJ.

injection procedures, low residual activity, and the quality of the bolus and resulting images.

CONCLUSION

An ideal syringe for bolus injection must meet the following criteria: (a) allow accurate measurement of small volumes; (b) retain low residual activity following injection; (c) have a sturdy needle; (d) have a large-gauge needle; and (e) be inexpensive. We concluded that the Monoject 1-mL tuberculin syringe with the 25-G × 5/8-in. permanent needle is the syringe that best meets these criteria and should be suitable for administering FPRNA doses.

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