TOOLS FOR THE INFILTRATION OF DEHYDRATED SPECIMENS WITH SILICONE RUBBER

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INTRODUCTION

Prior to forced impregnation with Biodur S 10/S 3 mixture, specimens covered with skin (fetus, fish) or capsule (testis, eye bulb), must be infiltrated with polymer. Intermediary solvent exits readily through thick fibrous covering tissue but the more viscous silicone rubber cannot penetrate and exchange fast enough to prevent a vacuum from developing within the specimen. Thus, this step is necessary to prevent compression-induced shrinkage. Also, final infiltration is often needed before curing to restore natural shape.

INFILTRATION OF SILICONE RUBBER

Most attempts to simply inject the S 10/S 3 mixture with a syringe will fail, as pressure on the plunger is far from sufficient to propel such viscous fluid through the usual needle. Table 1 shows some dimensions of disposable syringes. Special notice should be taken of the front surface area of the plungers. Maximum obtainable pressure has been calculated by assuming that the user will exert a thumb force of 20 Kg/cm^2. In practice, most female technicians will use considerably less.

Another reason why these calculations are liable to result in too high an available pressure is because they neglect the detracting influence of friction. Data shown in Table 1 are provided only as relative values and to establish an order of magnitude. The pressure that can be generated with a 1 ml syringe, for example, (more than 100 bar) turns out to be quite remarkable when compared to the low pressures obtainable with larger types.

Pressure is equal to force divided by unit area. The reader is well-aware that a small syringe filled with water and fixed to a thin hypodermic needle is much more easily emptied than a larger one. The needle creates enormous flow resistance which, according to Hagen-Poiseuille's law depends on its length, the viscosity of the fluid (here 700 m Pa's) and the fourth power of its tubular radius.

So, for silicone infiltration, large needles have to be used. The #1 hypodermic needle (20 G x 1 1/2 inch) is the most narrow needle found practical for this step. In fact, for larger specimens, such as fish, all-steel needles, 4 inches in length with a gauge between 19 and 14 are recommended. Needles with internal diameters larger than 2 mm leave big holes and much of the injected polymer may leak out.

The 1 ml size (Fig. 2, A) is the only conventional syringe that will develop enough pressure to be useful for silicone injection. One drawback, however, is that the user's hand hurts after the 10th filling. Despite numerous other limitations (the plunger kinks easily under the heavy pressure; the syringe cannot be filled through the needle; the needle slips

off once it has been lubricated with silicone) it works.
Its minute volume is a real handicap (a testicle has to be injected with 8 ml) — but it does generate a serviceable pressure (Table 1).

The automatic syringe (Fig 2, B) has a leverage grip, the ratchet of which propels a metal plunger rod. Its volume of 10 ml is sufficient but its diameter of about 16 mm limits the pressure that can be obtained. When used with silicone, the automatic syringe becomes heavily stressed. This notwithstanding, it is recommended for stronger users, injecting small volumes. The model that employs a rubber plunger can be improved by replacing its glass barrel with an (unbreakable) aluminum or stainless steel unit. After use, the model using a metal plunger in an interchangeable glass barrel must be carefully cleaned before residual S 10 becomes too viscous. In any case, the needle mount ought to be equipped with a Luer-lock cone. Spare sets of washers and rubber plungers also are necessary.

For infiltration of larger volumes, certain kinds of grease guns are quite useful. They generate pressures of several hundred bar. The cheap cartouche-guns, containing one-component silicone for caulking, turned out to be too weak for our purposes. The author's personal preference is the old-fashioned, bolt-type grease gun (Fig 2, C) with a plunger employing a leather washer. Its screw permits fine adjustment of the outflow. The grease-fitting nozzle at its outlet must be removed and the tube altered for the installation of a Luer-lock cone. Such cones are available commercially, either from a supplier of syringe systems or as tubing adapters (Fig 2, D).

The same change is necessary to adapt the outlet of a larger, lever-action grease pump of the type shown in Figure 2, E. This type will generate sufficient pressure (400 bar), however its rubber washer will suffer somewhat from cleaning with acetone. Both of these types of grease guns must be fixed to the work table and their output tubes are rather stiff.

POLYMER MIXTURE FOR INFILTRATION

The Heidelberg Plastination Folder (1985) recommends the following mixture for infiltration (in parts by volume):

Biodur S 10 Silicone -- 100 S

3 Hardener -- 1 S 6

Gas Cure -- 2

One might inject already-used, hence more viscous, S 10/S 3 mixture, however higher pressures and thicker needles will be necessary.

A tip that will discourage the leakage of injected silicone is as follows:

1) Draw 0.05 ml Biodur Hardener S 2 into a 1 ml disposable syringe.

2) Fill the syringe with S 10/S 3 mixture.

3) Install a large-gauge disposable needle and infiltrate within a few seconds.

Gelation of the polymer will occur within two minutes but the mixture will begin dissolving the syringe. Thus, one must discard both syringe and needle.

SOURCES OF EQUIPMENT

Automatic syringes are sold by companies serving veterinarians, especially large-animal practitioners. Sizes larger than 10 ml are not powerful enough to inject silicone. Models of 5-ml capacity are quite useful. The price is around $60.00.

Grease guns are cheaper (about $15.00). If the bolt-type is not available in automobile parts stores, try shops specializing in marine equipment.

Attempts by the Heidelberg Plastination Laboratory to construct an infiltration machine resulted in a $1,000.00 prototype (which failed to develop sufficient pressure) and a highly sophisticated $3,000.00 model, employing a reciprocating pump, driven by compressed air. The latter works very well but must be dismantled and thoroughly cleaned after each use.

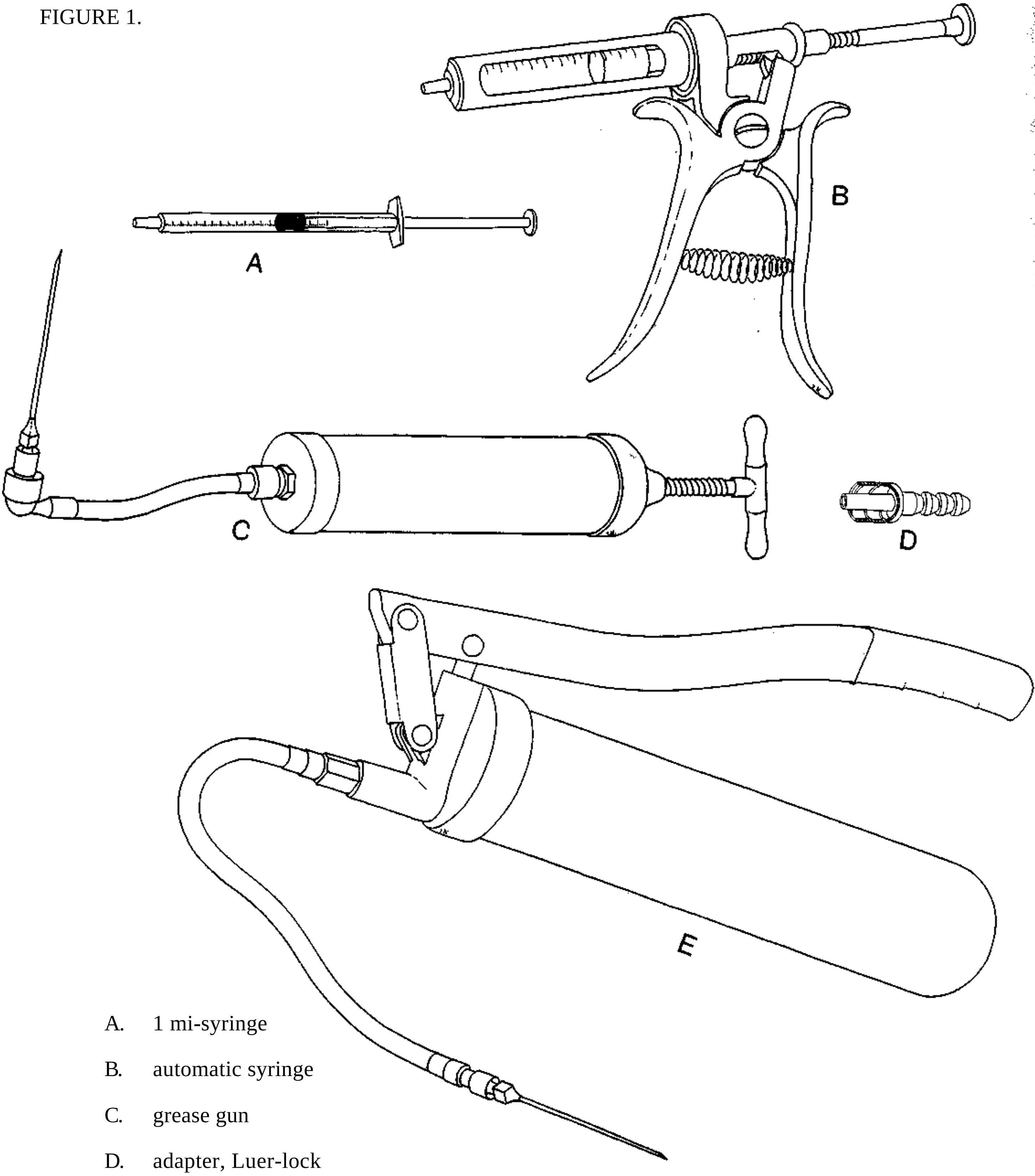
SUMMARY

Silicone-infiltration of specimens covered by skin or capsule requires 50 to 200 bar of pressure. Simple tools that are useful for this purpose include the 1-ml conventional syringe, low-capacity automatic syringes and certain types of grease guns.

TABLE 1. PRESSURES OBTAINABLE WITH CONVENTIONAL (DISPOSABLE) SYRINGES

SYRINGE VOLUME (in ml),	INNER DIAMETER (in mm)	FRONTAL AREA OF PLUNGER (in sq mm)	MAXIMUM OBTAINABLE PRESSURE (at 20Kg/sq cm) (in bar)
1	4.5	15.9	125.0
2	10.0	78.5	25.0
5	13.0	132.0	15.0
10	16.0	200.0	10.0
20	20.0	314.0	6.3
60	27.0	572.0	3.5

FIGURE 1.



A. 1 mi-syringe

B. automatic syringe

C. grease gun

D. adapter, Luer-lock

E. grease pump