The mechanism of ecchymotic formation is not understood. There may be qualitative differences between the hemorrhagic manifestations of petechiae and of ecchymosis, the latter possibly being more characteristic for certain conditions. High negative pressures may produce many petechiae without a tendency to form an ecchymosis.

The ecchymosis test is a simple, painless, clinical procedure which permits rapid readings and which may prove to measure more adequately the strength and hemorrhagic diathesis of skin capillaries than the various methods of petechial counts hitherto employed in man. It can be used in different regions of the human body and can also be applied to experimental animals. With it, the local or systemic effect of drugs, chemical agents, and other treatments can be tested.

References

1. COPLEY, A. L. (To be published.)
2. COPLEY, A. L., and KOZAM, G. Unpublished data.
3. PECK, S. M., and COPLEY, A. L. *New Eng. J. Med.*, 1946, **235**, 900.

Method for Making Cartesian Divers

C. LLOYD CLAFF

Laboratory for Surgical Research, Harvard Medical School, Boston, and *Marine Biological Laboratory, Woods Hole, Massachusetts*

The problem of making Cartesian divers is among the first to confront the investigator who becomes interested in Cartesian diver technique (*2*, *3*). This heretofore time-consuming and difficult operation can be reduced to a controlled routine procedure by the method to be described. This method differs from those described by Boell, Needham, and Rogers (*1*) and Holter (*2*) in that, instead of being a free-hand operation requiring considerable practice and skill in glass blowing, the various stages in the process are carried out in a jig which keeps the capillary in alignment at all times. Not only do the divers tend to be more nearly uniform and symmetrical but, by slight modification of the technique, it is possible very easily to make flat-bottomed divers (Erlenmeyer type) (*2*) and divers with either thick or thin tails.

Thick-walled Pyrex capillary tubing is selected. This may vary in outside diameter from .030″ to .060″ (0.762–1.524 mm), depending on the size of diver desired. A hot needle-point flame is adjusted on a micro-gas burner[1] using a mixture of gas and compressed air. The jig[2] (Fig. 1A), made of aluminum or brass, is composed of two parts, a stationary part attached to a handle and a removable part. There are two sets of paired holes in the jig, one each for making divers with relatively thick tails and with thin tails. In the first set, the paired set of holes are the same size; in the second, the paired holes differ in size. (The holes in the removable section are all the same size, being made by a very small drill—#77 drill, .018″.) This is done so that the thin rod of the "blank" will not wobble while it is twirled in the jig.

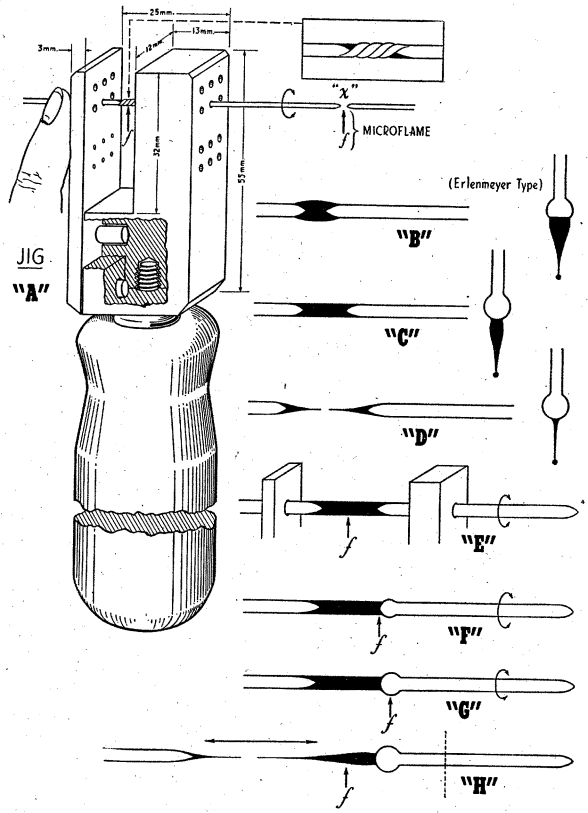

FIG. 1

Suitable drills for making the holes which will accommodate capillaries with outside diameters of .038″–.057″ are as follows: #53, .059″; #54, .055″; #55, .052″; #56, .046″; #57, .043″; #58, .042″; #59, .041″; and #60, .040″. When a capillary of convenient length has been selected it is inserted into the hole in the jig which best accommodates it so that it can be twirled easily, without wobbling. With the capillary inserted in the jig so that about 20 mm protrudes from the left side, the jig is held in the left hand in such a manner that the forefinger of that hand can push lightly against the protruding capillary and, when necessary, keep it from turning, and also in such a manner that the flame melts the glass in the middle of the jig (Fig. 1A). When the capillary is collapsed and the glass is molten over an area of 3–4 mm, the capillary protruding from the left side is held with the forefinger of the left hand, and the glass on the right-hand side of the jig is twisted 3 or 4 complete revolutions. This effectively seals off the lumen of the capillary from the rod and helps eliminate air bubbles. The pressure from the left forefinger is then released,

[1] A suitable micro-gas burner is the Orthodontic Blow Pipe #11, distributed by S. S. White Dental Manufacturing Company, Philadelphia, Pennsylvania.

[2] The jig is available from Carl A. Moeller, 242 Warren Street, Randolph, Massachusetts.

the entire capillary being allowed to spin freely back and forth in the flame. The result will be a solid rod of glass, 3 or 4 mm long, where the flame has collapsed the capillary. This first step must be carried out as outlined to preclude air spaces in the glass rod.

If thick tails and flat-bottomed divers are required, the capillary should be turned to and fro in the flame until the molten glass has assumed a form slightly larger than the original capillary (Fig. 1B).

If medium-thin tails and round-bottomed divers are desired, the glass is pushed to the left of the jig, the solid rod section reheated, and, while being held with the forefinger of the left hand, the capillary is pulled to the right until the desired thickness is obtained. After releasing pressure on the capillary, it is reheated and turned to and fro until the solid rod becomes uniform throughout (Fig. 1C). To complete the "blank," pressure is again applied with the forefinger of the left hand and the capillary sealed approximately 25 mm from the right-hand side of the jig (Fig. 1Ax).

If very thin tails are desired, a "blank" is produced as shown in Fig. 1B. This is removed from the jig before the capillary is sealed at "x." The solid rod portion is then reheated and removed from the flame. Just before the red glow has almost disappeared from the glass, it is pulled apart (Fig. 1D). The result is a thin tail ending in a thin thread of glass. This is broken a few millimeters from the end of the tail. The capillary is sealed off approximately 40 mm from the solid rod portion. The "blank" is again returned to the jig, this time, however, in one of the lower sets of holes so that the thin portion of the tail fits into one of the very small holes. To form the bubble of the diver, the "blank" is twirled to and fro in the jig while the flame is applied to the solid portion of the tail. When this is red hot, the jig is moved slightly to the left. Here one should watch carefully for the cone-shaped junction of the capillary and solid rod to flatten out. If the jig is moved a little more to the left, a bubble will form. The twirling to and fro should be continued until the bubble is the desired size. The "blank" is then withdrawn and twirled until it is cool (Fig. 1E, F, G).

In making divers with thick or medium-thick tails, it is not necessary to remove the "blank" from the jig, inasmuch as all operations are carried out in one set of holes. After the bubble is formed, the "blank" is removed, and, if the tail has not been previously drawn out to a thread of glass, it is done at this time (Fig. 1H). The capillary is cut 8–10 mm from the top of the bubble to form the neck of the diver.

Prior to being weighed and calibrated each diver should be examined microscopically to see that the bottom is not cone-shaped and that there are no air bubbles in the solid tail portion.

Calibration

The total gas volume of each diver is determined by weighing it both empty and filled with mercury (*4*). Having determined what volume is to be used for the bottom drop, NaOH seal, and oil seal, the correct weight of the diver (g) for its particular volume necessary for it to float in the selected medium is found by using the following formula:

$$g + V_O P_O + V_L P_L = V_A + \frac{g}{2.23} \times 1.321$$

$$g - \frac{g}{2.23} \times 1.321 = V_A \times 1.321 - V_O P_O - V_L P_L$$

$$g \left(1 - \frac{1.321}{2.23}\right) = V_A \times 1.321 - V_O P_O - V_L P_L$$

$$g = \frac{V_A \times 1.321 - (V_O P_O + V_L P_L)}{1 - \frac{1.321}{2.23}}$$

where g = weight of diver glass (final), V_O = volume of oil seal, P_O = density of oil (0.8), V_L = volume of aqueous phase (medium + NaOH), P_L = density of aqueous phase (1.0), 1.321 = density of flotation medium, 2.23 = density of Pyrex glass, and V_A = total volume of diver.

The amount of Pyrex glass which has to be added to the tail is the difference between the actual empty weight of the diver and the theoretical correct weight necessary for it to float in a particular medium. Glass from a thin glass thread is added until the diver weighs within 0.1 mg of its correct weight, and then the glass is fused into a ball at the end of the tail.

The formula for the calibration of K, the diver constant for an experimental temperature of 27.8°C, 1.0 mm³ medium, and 1.0 mm³ each of NaOH and oil, respiration in air, is as follows:

$$K_{O_2}^{27.8°C} = \frac{V_{AIR}^* \times \frac{T}{T+t} + (V_{LIQ}^{\text{at } t°C}\, \alpha_{LIQ}) + (V_{OIL}\, \alpha_{OIL}^{\text{at } t°C})}{760 \times 13.54}$$

where V_{AIR}^* = total air volume *minus* (vol. liquid + vol. oil), T = temperature of absolute zero (273°), t = temperature of experimental °C (27.8°), V_{LIQ} = NaOH + medium, α_{LIQ} = solubility of O_2 in medium and NaOH at t° C (assumed .029), V_{OIL} = volume of oil seal, α_{OIL} = solubility of O_2 in oil at t° C (assumed 0.1), and 13.54 = weight of 1 cc of mercury at 25°C. (See International Critical Tables for values of α_{O_2} and α_{CO_2} at different experimental temperatures.)

Numerical values in the above formulas may be substituted for the ones given when such values more accurately reflect the actual conditions of the particular experiment and materials used.

The formula for a flotation medium (*2*) is: 27.2 gm of $NaNO_3$,[3] 13.7 gm of NaCl, and 59.1 gm of H_2O (density = 1.321).

References

1. Boell, E. J., Needham, J., and Rogers, V. *Proc. roy. Soc. Lond.*, 1939, **127**, 322–356.
2. Holter, H. *C. R. Lab. Carlsberg*, 1943, **24**, 399–478.
3. Linderstrom-Lang, K. *C. R. Lab. Carlsberg*, 1943, **24**, 333–398.
4. Peters, John P., and Van Slyke, Donald D. *Quantitative clinical chemistry*. Vol. II: *Methods*. Baltimore: Williams & Wilkins, 1942. P. 5.

[3] The salts should be heated in a 100°-C oven overnight to be sure they are anhydrous before weighing.