The invention relates to a device for instructing students of medicine and nursing, medical technicians, and the like, in the correct and most expedient technique of piercing veins for the sampling of blood, injection of fluids, etc. In particular, it relates to a life-like replica of a human arm or leg embodying natural appearance and feel which is exceptionally well suited for imparting essential knowledge and confidence to such students without the necessity of experimenting on a live patient.

An object of the present invention is to provide a realistic model of a human arm or leg which may be pierced repeatedly by needles without losing its natural appearance or effectiveness as a teaching aid. A further object is to provide such a replica from which needle marks may be readily removed. Another object is to provide such a replica in which the location of the veins may be determined by touch as in the human arm. Additional objects will become apparent as the following detailed description proceeds.

In Fig. 1 is illustrated an overall perspective view of an arm showing the insertion of the needle of a syringe into the tube simulating the cephalic vein. Fig. 2 is a cross sectional view of the arm shown in Fig. 1 taken along lines 2-2. The present invention will be described particularly with respect to such an arm.

In accordance with a preferred embodiment of the present invention, the simulacrum of the arm 18 shown in Fig. 1 is a hollow rubber latex form (prepared in a manner hereinafter more fully described) with tubing 11, which simulates the cephalic vein, passing through the arm. The dimensions of cavity 12 are not critical but should preferably be at least about three-fourths of an inch in depth, about two inches in length and at least about an inch and one-half in width. The cavity may have various geometric shapes, e. g. the rectangular shown; it has been found that cavities which are triangular in cross-section, i. e. are wedge-shaped, are particularly easy to produce by molding. Cavity 12 is filled with a thermo-fusible plastic substance 13, such as Korogel which is an elastic, pliable polyvinyl molding jelly, hereinafter referred to in greater detail. Tube 11 preferably extends through the entire length of the arm terminating in small valve 14, substantially concealed in the clenched fingers of the hand or in a similarly unobstructive location. This valve may be of any suitable type, e. g. a small pinch clamp may be used which is held open manually while the artificial blood is introduced and air is forced out and then closed when the tube is filled.

Tube 11 is preferably of gum rubber construction. It should be of greater diameter and should be inset at a greater depth at injection sites in the upper part of the arm than in the lower part, e. g. on the back of the hand. These variations correspond, of course, to the nature of veins in a human arm. The actual tapering of the human veins is preferably simulated so that there exists an increased difficulty in locating and piercing them at locations in the lower regions of the arm and in the hand. Tapered tubing may be made by a careful dipping process known to those skilled in the art but it is equally satisfactory, for purposes hereof, and substantially less expensive to join lengths of different uniform diameter tubing at locations between the various injection sites. Thus, tubing 11 preferably comprises a length of larger diameter tubing 15 which after passing through cavity 12 is connected to a smaller diameter tubing 16 at some location between cavities 12 and 17 and then through wall 11. The dimensions of the diameter of the artificial veins may thus be obtained at a plurality of locations along tube 11 depending upon the number of injection sites. It should be understood that any number of such cavities may be located along the arm although only three are shown in the drawing and that several veins may be simulated although only two are illustrated. Additional description of tube 20 which simulates a second vein, e. g. the basilic vein, is considered unnecessary; it is illustrated to show the manner in which more than one vein may be simulated and how a plurality of reductions in diameter of the tube may occur. Tube 20 comprises sections 21 and 22 joined by adapters 24 and 25. The fusible plastic material, e. g. Korogel, employed in cavities 12 and 17 does not readily adhere to the latex surface of such cavities. It is therefore ordinarily necessary to provide a means for retaining the plastic therein. This may be accomplished by forming such cavities with undercut sides into which the plastic may flow while hot but which upon cooling will be retained by the rim or edge of the cavity. Because of the problems of molding or casting undercuts it is preferred, however, to provide
the cavities with projections which, along with the tube passing through the cavity, become imbedded in the plastic and form adequate retaining means.

The tubes simulating the veins, e.g. tube 11, are positioned within the hollow arm and preferably secured to the wall by wire brackets 19 embedded in the rubber, at several points along the arm. Instead of wire brackets, however, there may be employed any suitable means for maintaining the tube in the desired position. Thus, pressure sensitive tape may be employed or the tube may be cemented to a wall with a suitable rubber adhesive. It is not essential that the tube be fixed to the wall in a more permanent manner than results from its passage through the several cavities; but to avoid any possibility of separation of the various lengths of tubing at the connections and consequent fluid leakage, it is preferred that it have a minimum amount within the arm.

Fig. 2 is shown, somewhat more clearly, the relationship of the thermally fusible substance 13 in cavity 12 to the rest of the arm as well as how the cavity itself is disposed in the arm. The juncture between the surface of the thermally fusible substance in the cavity and the surface of the remainder of the simulacrum, comprising latex, is smooth and non-obvious. Thus, these surfaces are essentially continuous and the material in the cavity is conformed to the contour of the arm. The veins 11 and 20 are shown passing through the cavity immersed in the thermo-plastic material therein and essentially parallel to the surface of the arm. Cavity 12 itself is, as indicated above, of the same material as the rest of the arm, e.g. latex, and in the absence of the thermo-plastic and the veins, cavity 12 appears simply as an indication in the surface of the arm.

The simulacrum of the arm is preferably yeldable and made of latex rubber although other substances may be used without departing from the scope of the invention. Thus, instead of rubber other suitable materials, such as those employing in dolls, manikins and prosthesis, may be employed. Various commercial polyvinyl resins are suitable for this purpose, for example, Geon 121 plastisol (a product of B. F. Goodrich Chemical Co.), Marvinol VR-10 (a product of Naugatuck Chemical Div., U. S. Rubber Co.). The arm may of course be made of non-yeldable material such as plaster but it is obviously less realistic in such form and consequently not as suitable for its intended purpose. The entire arm may be made from a molding jelly such as Korogel, which would eliminate the need for cavities at injection sites. Such simulacra are not sufficiently durable, however, to be of general applicability.

A simple technique for the manufacture of a latex simulacrum of an arm such as is shown in the drawing is as follows: A person thrusts his arm up to the shoulder into a long narrow bag containing molten agar-molding composition and the bag, with arm in place, is then immersed in cold water for about one-half hour to set the composition. Before withdrawing the arm the bag is slit at the wrist to permit the large part of the hand to pass out. After the arm is removed, the mold is tied at the location where the slit was made to reform the mold. Plaster or other material suitable for a temporary positive, e.g. wax, is then poured into the agar mold. After allowing the same to set, the agar mold is removed and the temporary plaster positive remains. Cavities are then cut in the arm at the desired locations and a negative plaster piece mold, i.e. a mold comprising numerous pieces to permit accurate reproduction of undercuts in the arm, is prepared. For a detailed description of preparing piece molds see "Molding and Casting" by Carl Dake Clark (1938) John O. Lucas Co., pages 144 et seq. From the plaster piece mold may then be prepared any number of latex arms by pouring the liquid rubber and permitting the same to build up to at least about 1/4" and preferably to at least about 1/2" thickness. When the rubber is substantially coagulated, finely divided vermiculite or molten wax is poured into the arm within the mold to prevent shrinkage. When the rubber has completely coagulated, the negative piece mold may be removed. In a modification of the above technique the temporary positive containing the cavities may be immersed in a bag containing agar-molding composition, removed after the composition has set, and after introducing a suitable coagulating agent, the liquid latex may be poured directly into the agar mold until a rubber positive of desired thickness is produced. A simple agar-composition suitable for use in accordance with the above may be prepared by mixing 40 parts of water, 8 parts of powdered agar, 1 part of borax, and 30 parts of sorbitol.

The simulacrum may also be prepared by other techniques, e.g. slush molding, casting, dipping, spraying, etc. The method of preparing constitutes no part of the present invention, however, and further detail is considered unnecessary. It is highly desirable and preferred that the simulacrum be hollow in order to facilitate insertion and removal of the gum rubber tubes. After the tubing is placed in a hollow simulacrum, it is preferably filled with a suitable paste to give the arm weight and body. For this purpose granular vermiculite, sawdust, etc. may be used.

Solid simulacra having vein-simulating conduits bored therein and a short connecting length of gum rubber tube or the like within the cavities at injection sites into which needles may be inserted may be employed in accordance herewith. This embodiment has particular appeal from the practical standpoint of removing entire lengths of tubing when only the section of tube at a point of injection must be replaced is eliminated. The apertures in the walls of the cavities can, in such a case, be provided with suitable female fittings to receive the male ends of a replacement tube. By the term rubber latex, as employed here, it is intended to include rubber latex whether concentrated or not and either natural or synthetic. It may be vulcanized in the dispersed condition, or it may be vulcanized in the more usual way to a soft product after disposition and drying.

Korogel, which is a plasticized thermally fusible polyvinyl resin is preferred as the filler in the cavities at injection sites but any other suitable material which can be readily molded into shape and which is penetrable by a needle substantially as is skin and subcutaneous tissue, may be employed. Korogel has the additional advantage that individual needle marks therein cannot be readily seen; thus, it is only necessary to re-surface the area of injection by fusion after a substantial number of holes have been
made and students are able to observe from a concentration of marks where the proper injection should be made.

The vein simulating conduits are preferably of gum rubber but other materials which have sufficient elasticity to seal the puncture made by a needle can also be used. Thus, for example, Tygon tubing (a modified vinyl resin product of U. S. Stoneware Co., Inc.) has a certain amount of self-sealing ability and may be used. Its transparency is particularly in its favor. But its elasticity is much less than that of gum rubber and, therefore, it cannot withstand a comparable number of injections without leaking fluid. Other materials will suggest themselves to one skilled in the art.

A primary purpose of the present invention is to train persons to correctly insert a needle into the vein. The trainee making an injection after a large number of others have done so can readily determine the proper injection location by observing that area containing the most needle marks. This is not fair to teacher or student. In accordance, herewith, such marks may be quickly and effectively removed by the application of heat to the injection site. A preferred method is simply to pass a heated spatula or other gum smoothly implement over the area. The complete resurfacing operation takes only a few minutes and after permitting the material to completely solidify, the arm is unblemished and ready for the next student. Such resurfacing ordinarily need only be done after a day’s use.

Whereas the foregoing description has been directed to a complete arm or leg, it should be understood that it is within the scope of the invention to employ portions of an arm or leg embodying the novel features herein described.

The veins in a human arm tend to roll or "side-slip" under the skin and tissue when pressure is exerted thereon. This may be simulated in the arm of the present invention by inserting beneath the tube, within the cavity, a layer of sponge rubber. Another method of simulating this is to immerse the tube in a narrow channel within the Korgel, in a heavy liquid such as mercury.

Having thus described my present invention, what I claim as novel and desire to protect by Letters Patent is as follows:

1. An anatomical model comprising a simulacrum of a human limb; a concavity in the surface of said simulacrum; a vein-simulating conduit beneath the surface of said simulacrum which passes through said concavity with at least that portion of the conduit passing through said concavity being capable of sealing itself after puncture by a needle; and a fusible plastic substance, which is penetrable by a needle substantially as is human skin and subcutaneous tissue, disposed within said concavity above said conduit.

2. An anatomical model comprising a yieldable simulacrum of a human limb, a concavity in the surface of said simulacrum; a vein-simulating conduit beneath the surface of said simulacrum, which conduit is capable of substantially sealing itself after puncture by a needle, extending through said concavity; and a fusible plastic substance, which is penetrable by a needle substantially as is human skin and subcutaneous tissue, disposed within said concavity above said conduit and molded to the contour of said simulacrum.

3. The anatomical model of claim 2 wherein the simulacrum substantially comprises latex rubber.

4. The anatomical model of claim 2 wherein the fusible plastic substance comprises a thermally fusible polyvinyl resin.

5. The anatomical instruction model of claim 2 wherein at least that portion of the conduit which passes through the concavity comprises gum rubber.

6. An anatomical instruction model comprising a substantially hollow, thin-walled, latex rubber simulacrum of a human limb; a concavity in the surface of said simulacrum, a vein-simulating conduit comprising a gum-rubber tube within said simulacrum extending through the said concavity; and a thermally fusible plastic substance penetrable by a needle substantially as is human skin and subcutaneous tissue, disposed within said concavity above said conduit and molded to the contour of said simulacrum.

7. The anatomical instruction model of claim 6 wherein the diameter of the vein-simulating conduit is substantially less in the lower section of the limb than in the upper section.

8. The anatomical instruction model of claim 6 wherein the vein simulating conduit terminates in the lower section of the limb in a means for permitting air to escape as the tube is filled with liquid and substantially preventing liquid escape.

9. The anatomical instruction model of claim 6 wherein the vein simulating conduit comprises a plurality of sections of tubing joined together, the diameter of each succeeding section diminishing as the conduit passes down the limb.

10. The anatomical instruction model of claim 6 wherein the limb is an arm and said hollow thin-walled simulacrum is filled with a packing material to render the same solid and realistic to the senses of sight and touch.

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