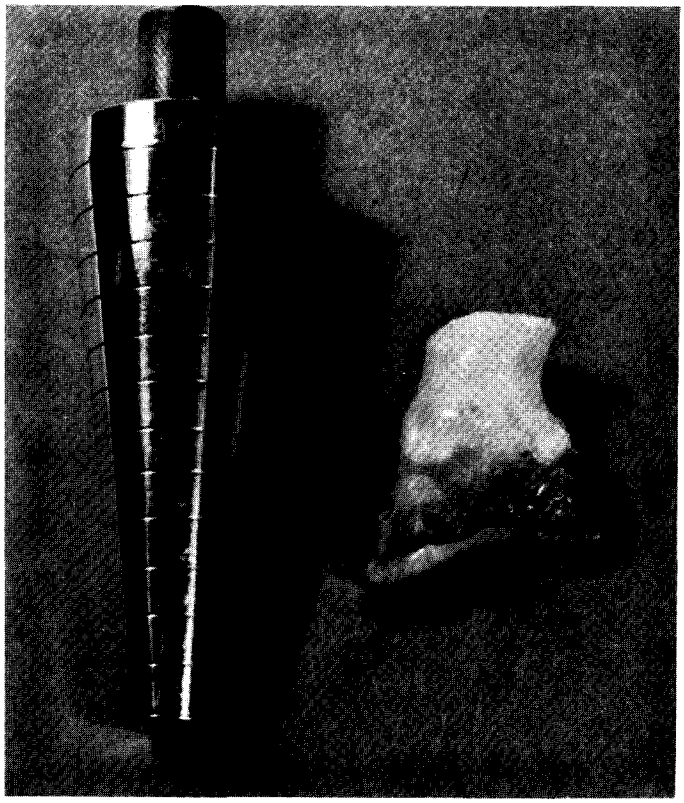

"Homemade" graduated obturator used to measure the inner diameter of the lower partly muscular ring of the homograft. Homograft freed of adventitia, fat, and most of the muscle. Further trimming is not done until the time of surgery.

Homograft Valve Techniques

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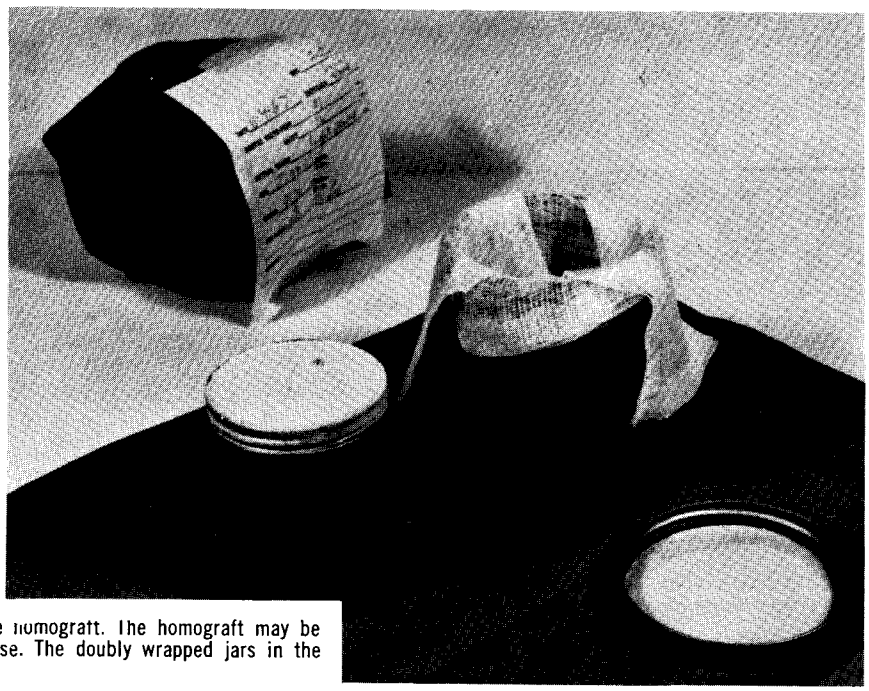
HOMOGRAFT replacement of the aortic valve is just beginning to gain acceptance in the United States even though use of aortic valve homografts became a reality very close to the site of this meeting more than ten years ago, in Toronto, Ontario, with work by Dr. Gordon Murray. Dr. William Young, at our Medical Center, considers homografts to be the replacement of choice for the aortic valve at this time. This surgery consists of replacing a diseased aortic valve by a human aortic valve taken from a cadaver.

I would not describe my duties to you connected with homograft valve surgery if there were not such a strong possibility that this will be a more and more common way of treating aortic valve disease. Of the 35 patients in whom Dr. Young has placed homograft valves only two have died, neither of them from a valve failure. In over one year's time, there have been no late deaths or thromboembolic complications.

As part of this surgical team, my duties now involve dissecting and sterilizing the cadaver valves and putting them in a nutrient medium. I should like to discuss these procedures with you in more detail.



Double sterile glass jars containing Hank's Solution and the homograft. The homograft may be kept at 4°C. in this solution for at least 12 days before use. The doubly wrapped jars in the background show description of the contained homograft.

The Donor

The donor should be between 10 and 60 years of age and we prefer to remove the valve within 12 hours of

death, but do take valves up to 24 hours after death if the body has been refrigerated. After the heart is removed at routine postmortem examination using clean, if not sterile, technique we dissect the valve, cut away most adventitia and fat, and trim away most of the ventricular myocardium. We also check the valve leaflets for holes and for cholesterol plaques and bathe the valve in sterile saline solution to see if the leaflets open and close properly. Any blood still adhering to the valve is rinsed off in this saline solution.

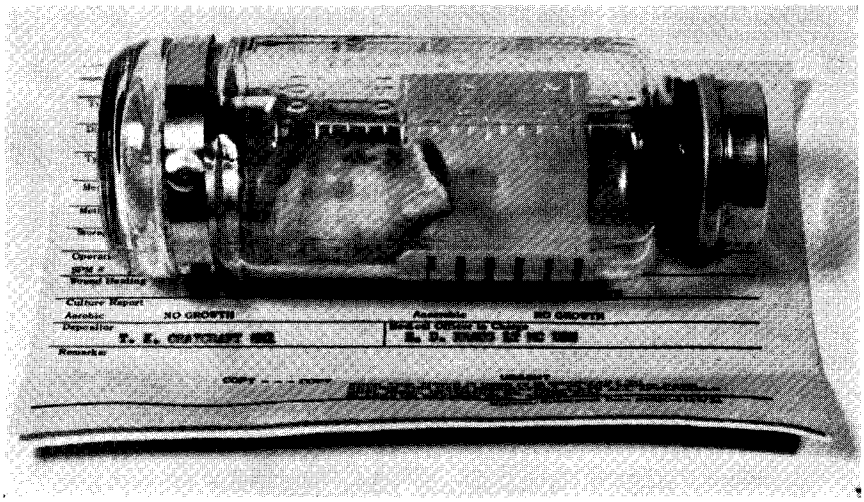
As aortic valves vary considerably in size, we measure them at both the ventricular and aortic ends and then record these measurements on the jar in which the valve will be stored. This information will be used to match valves as closely as possible to the size of the patients' aortic roots.

Sterilization

Sterility is a critical aspect of homograft use and this is, to a large extent, the technician's responsibility. A culture is first taken to determine if the valve has been infected before the donor's death. There are several means of sterilizing homograft valves including beta-propiolactone (BPL), ethylene oxide, and irradiation. At our hospital, these valves are sterilized with 1% beta-propiolactone in sodium bicarbonate buffered saline solution at 37°C for no less than two hours, but no more than three hours. The jar is agitated every 30 minutes to remove CO_2 bubbles that form on the valve tissue. We believe that bubbles might otherwise interfere with proper sterilization.

After removing the valve from the incubator, we rinse it twice in a sterile cold isotonic saline solution and take another culture, as a check, on the sterilizing procedure. We have never had a positive post-sterilization culture.

After the leaflets have been rechecked, the valve is ready for storage in a nutrient medium. We use Hank's Balanced Salt Solution with added serum, penicillin, and streptomycin. We can keep the valves in this solution for seven days or more. They are, of course, kept under refrigeration at 4°C. If we do not expect to use valves within 12 days in this nutrient medium we freeze-dry them before seven days to preserve them for months—or years.



This vacuum bottle contains a freeze-dried homograft. There is a description of the homograft on the label and on the 5"x8" file cards.

Dr. Young prefers to use "fresh valves", that is, he prefers to use a valve within 12 days rather than one which has been freeze-dried.

Freeze-dried Valve

When we do not have a fresh valve of the proper size, we use the freeze-dried valve. A freeze-dried valve can be reconstituted in 30 minutes by placing it in a solution of 500 ml. distilled water, penicillin (2000 units/ml.) and streptomycin (2 mg./ml.) Of course, an antibiotic would not be used if records show that the patient is allergic to it. Antibiotics are used in the several solutions to protect against contamination following the initial sterilization.

The homograft valve selected to be used is then removed from its jar and rinsed in isotonic saline solution with penicillin (500 units/ml.) and streptomycin (50 mg./ml.). Again the leaflets are checked and final trimming of the homograft takes place.

So far, I have described how the valves are prepared. Now I would like to give a simplified description of how the valve is actually placed in a patient.

Replacement Steps

First, the diseased valve is removed. Then the surgeon measures the size of the aortic ring to determine the size of the homograft valve that will be used. The surgeon then attaches guide sutures to the annulus of the homograft and to the aortic ring of the patient, and then inserts the valve into place.

Once the homograft is in place against the annulus it is inverted into the ventricle and in so doing it is turned inside out. This permits suturing the ventricular end of the homograft just below the annulus. Continuous suturing is used here. The valve is then brought back up from within the ventricle and sutured to the aortic wall.

I mentioned earlier that of the 35 patients with homograft aortic valve replacements (over a 14-month period) 33 are living. Of the two patients who died, neither died from valve failure. One patient died two months postoperatively from a severe asthmatic attack. The other died three days postoperatively from an infarct of the myocardium. Postmortem examination of the heart of the patient who died two months postoperatively showed that the suture lines were well healed. There were no blood clots. No patients have received anticoagulants and there have been no emboli.

Summary

In summary, homograft valve surgery holds much promise and may well become a surgical procedure used in the hospital where you work. In less than six months after his surgery each surviving patient has returned to work and to normal activity. None of them are taking anticoagulant drugs. There have been no emboli and no bother or expense of prothrombin time determinations. One patient is enjoying a extended vacation in Europe—free of the need to be near a hospital for tests, and with no need to take drugs.

Final trimming of the homograft as it is done at the operation.

Addendum

NOTES ON BETA PROPIOLACTONE (BPL) STERILIZATION

BPL is a water soluble chemical which, in a 1% solution of 37°C, has been shown to destroy bacteria and their spores, viruses and fungi, even in the presence of protein, without materially weakening connective tissue such as artery walls or valve leaflets. During the sterilizing process the BPL hydrolyzes to beta-hydroxypropionic acid and this product has no further bactericidal effect and is relatively safe. BPL is quite stable in concentrated form but should be refrigerated to delay polymerization.

BPL will blister skin—spilled solution should be washed away with large amounts of water. The same applies to the eyes and mucous membranes. It is irritating to the respiratory tract and should be used only in well ventilated rooms and preferably under a hood.

It is customary to initially prepare a 10% beta propiolactone solution by combining cold concentrated BPL with cold distilled water in a ratio of 13 to 137. This is shaken to dissolve the globules. This solution should be entirely clear—crystallization or cloudiness indicates that there has been deterioration of the BPL. This 10% solution will remain stable in an ice bath for several hours but generally is prepared immediately before further dilution to a 1% solution by adding it to a saline bicarbonate solution in the ratio of 150 ml. of 10% BPL to 1350 ml. of saline bicarbonate solution. The 1% solution is used immediately, covering the tissue to be sterilized and then incubated at 37°C for two or three hours.

The saline bicarbonate solution is prepared by dissolving 25.2 Gm. sodium bicarbonate and 12.75 Gm. of sodium chloride in 1500 ml. of distilled water (or proportionately smaller amounts of each.) This solution does not need to be sterile if freshly prepared as the BPL will sterilize it.

References

LoGrippo, G. A., Overhulse, P. R. Szilagyi, D. E., and Hartman, F. W.; Procedure for Sterilization of Arterial Homografts with Beta-Propiolactone, Laboratory Investigation 4:217, 1955.

Wilmot Castle Co.: Technical Bulletin No. 0818-1. Part No. 30075. Revised 6-30-62.

Source of Materials

Hank's Balanced Salt Solution X 1 200 ml. Grand Island Biological Company, 3175 Stanley Rd., Grand Island, N. Y. 14072.

Beta-Propiolactone—liquid concentrate. Wilmot-Castle Co., P.O. Box 629, Rochester, N. Y. 14602.

Aldrich Chemical Co., 2371 North 30th Street, Milwaukee, Wisconsin 53210.

Presented at the National Meeting of the American Society of Extracorporeal Circulation Technicians, Montreal, Quebec, June 9th and 10th, 1967.