

## SOME EXPERIENCES WITH A BONE BANK

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Transplantation of bone is a frequent procedure in orthopaedic surgery. Hitherto, autogenous transplantations have been usual, bone being taken from the same individual, usually from a tibia or iliac crest. The disadvantage of this form of transplantation is the longer and more severe operation, and the rather lengthy post-operative inconvenience from the donor site. In homogenous grafting, bone is transplanted from one individual to another. A successful operation of this kind was performed as early as 1878 by MacEwen, and has since been described by a number of authors, for both experimental animals and humans. However, a more systematic use of homogenous transplantation has only come into use in the last 2-3 years. In 1947, publications were issued from two different hospitals in New York, reporting good results of 100 operations of this type of bone grafting. The novelty lay in the fact that the transplant of bone had been preserved for varying periods in a frozen condition. This method of storage makes it possible to have bone grafts always available for use. A bone bank consists of bone removed at operations and stored in a sterile frozen condition for later use.

The organisation of a bone bank is based on the following facts and assumptions:

- 1) Homogenous and autogenous bone are equally useful; in both cases the graft dies, but its presence acts on the surrounding connective-tissue in such a way that it is transformed into bone by metaplasia. Thus, both act in the same way as the cell-free alcohol-extract of bone with which *Levander* and

others were able to induce bone formation in the muscles of rabbits. As the vessels accompanied by connective tissue grow into the Haversian canals of the graft, bone is formed and gradually the entire graft is reconstructed to form new living bone by "creeping substitution".

2) Neither the blood group nor the Rh factor are of significance, and no attention need be paid to them.

3) Bone can be stored in sterile containers in an ordinary refrigerator ( $+ 2-+ 6^{\circ}$ ) for three weeks, and at  $\div 15-\div 25^{\circ}$  indefinitely.

4) The donor must be controlled. Thus, his WR must be negative. Spirochaeta stored at  $\div 78^{\circ}$  were found to be still virulent after 4 months. He should have no history of infection for some time before the graft is taken. His sedimentation rate should preferably be normal.

5) Sulphonamides interfere with the calcification process.

6) The bone grafts should be stored dry. Carrel reported before 1920 that transplanted tissues e.g. bone, skin or other substances stored in Ringer's solution either do not heal or heal less well than when stored dry. In accordance with *Levander's* tests, this might be due to extraction of the osteogenetic active substance by the Ringer's solution.

7) Cortical bone is the best for stability, spongiosa for osteogenesis.

In transplantation a bone graft has a threefold function.

a) It gives stability.

b) It stimulates osteogenesis.

c) It serves as a matrix for the bone formation which assumes the shape and extent of the graft.

At the Orthopedic Clinic of the Karolinska Institute a bone bank was instituted in September 1948. Some of the bone is supplied by the clinic of thoracic surgery and consists chiefly of ribs from operations in non-infectious cases; some, consisting mostly of ribs and vertebral spinous processes, by the neurosurgical clinics; and some by the Orthopaedic Clinic, from amputations and other operations. Bone which is to be stored is divested of all its soft parts and placed in an ordinary

preserving-jar immediately after the operation. The jar has been previously sealed and sterilised in an autoclave. After receiving the bone, it is re-sealed and transferred to a deep freezer, where the temperature is kept at  $\div 13\text{-}\div 15^{\circ}$ . Before use the jar is removed to room-temperature for 30-60 minutes.

We have now used bone-bank bone from 75 different bone donors in 48 operations, with apparently good results in every case. In 4 cases there was a slight wound-infection, which scarcely had any connection with the transplant. As far as can be judged from an observation period of not less than four months, the healing can be said to have taken place in a normal way. Bone from the bone bank has mainly been used for spinal fusions. 12 were cases of scoliosis and 27 of lumbar disc-degeneration. There were also 3 cases of arthrodesis of the hip; 3 of pseudarthrosis, 1 of which had a large femoral cyst; 1 shelf-operation for the hip, and 1 of arthrodesis of the wrist. The bone was generally cut into small chips, partly to fill out all the recesses and partly to enlarge its surface, as, according to the above, bone formation proceeds from the surface of the graft. The transplant was used whole only when aiming to obtain stability; it was then usually taken from the femur or tibia. In these cases it was generally surrounded by small pieces of spongiosa bone.

When the containers were opened, small pieces of bone were cultured as controls. 11 samples, from 68 donors, gave a sparse growth of non-pathogenic or doubtful pathogenic staphylococci, and 1 a growth of pathogenic streptococci. Bone giving a positive culture was used in 9 cases without any apparent complications of any kind. Of the 4 cases in which slight infection occurred, the culture of the graft was positive in 1. The remaining 8 cases receiving grafts with positive culture showed perfect healing, including the case which received the bone with streptococci. The longest period of bone-storage before use was 67 days.

In summarising, it can be said that our experience with the bone bank has been very satisfactory; its use reduces the time and the severity of operation, and this is essential.

Operations which one would not otherwise dare attempt can be performed, and, as more bone is available than the patient himself could provide, both a more certain osteogenesis and a more stable osteosynthesis is obtained. Probably bone taken from a corpse, or even from an animal, might be used with equally good results, but, as our supply has hitherto been good, this question has not yet arisen.

#### SUMMARY

The theoretical and practical requirements of a bone bank were discussed. Bone can be kept sterile at  $\div$  15°C for practically as long as one likes. At the Orthopaedic Clinic of the Karolinska Institute bone from the bone bank, taken from 75 different donors, has been used for 48 operations, with good results in all cases. The use of stored bone means that in many cases there is a considerable reduction in the severity of the operation, and it is recommended for this reason.

#### RESUME

Discussion sur les conditions théoriques et pratiques de la constitution d'un stock d'os. On peut maintenir la stérilisation des os aussi longtemps qu'on le désire en les conservant à une température de moins 15°. A la Clinique Orthopédique de l'Institut Karolinska, des os provenant de stocks fournis par 75 différents donateurs, ont été utilisés dans 48 opérations avec de bons résultats dans tous les cas. L'emploi d'os stockés signifie que l'on peut dans beaucoup de cas réduire considérablement la gravité de l'opération est c'est pourquoi on le recommande.

#### ZUSAMMENFASSUNG

Die theoretischen und praktischen Forderungen einer Knochenaufbewahrungsstelle (Knochenbank) werden besprochen. Bei  $\div$  15 Grad Celsius kann man Knochen steril bewahren so

lange als man wünscht. An der Orthopädischen Klinik des Karolinska Institutes wurde Knochen von der Knochenbank verwendet, der von 75 verschiedenen Spendern entnommen war. Dies geschah in 48 Operationen und die Resultate waren gut in allen Fällen. Der Gebrauch von aufbewahrtem Knochen bedeutet in vielen Fällen eine beträchtliche Verringerung der Schwere der Operation und wird deshalb anbefohlen.