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Microbial contamination of femoral head allografts

股骨頭移植的微生物感染

Objective. To study the incidence of microbial contamination at the bone bank of the United Christian Hospital.
Design. Retrospective study.
Setting. Regional hospital, Hong Kong.
Patients. A total of 151 patients (33 men and 118 women) who underwent hip arthroplasty surgery and from whom femoral head allografts were retrieved between January 1994 and March 2000; and 81 patients in whom allografts were implanted.
Main outcome measures. Bone biopsies were taken from the femoral head and used to detect any microbial contamination that might have occurred during removal and after storage. The rates of infection among recipients and donors were also assessed.
Results. Of the 151 allografts, 94 non-contaminated allografts were implanted by the end of the study. Fourteen (9.3%) heads showed positive culture results after retrieval and were discarded. Four (4.3%) of the 94 stored allografts that were implanted tested positive for microbial growth, but the recipients of these allografts did not develop any clinical infection. Three (3.2%) had wound infections after implantation of the stored allografts although the grafts had previously been tested negative for any microbial contamination.
Conclusion. Our centre has a low allograft contamination rate. The wound infection rate among recipients was also low. The culture of a bone biopsy sample is a reliable method to detect contamination of bone grafts. However, the contamination rate among stored allografts should prompt orthopaedics departments to review allograft handling procedures, so as to minimise the chance of contamination.

目的：研究基督教聯合醫院骨庫出現的微生物感染事件。
設計：回顧研究。
安排：分區醫院，香港。
患者：1994 年 1 月至 2000 年 3 月期間，共 151 名病人（33 男 118 女）接受髖關節置換術，並截取同種異體股骨頭，其中 81 名病人接受同種異體股骨頭移植。
主要測量結果：在股骨頭抽取骨的活組織進行培養，以監測在截取股骨時以及植入異體骨後可能出現的微生物感染，並分別對移植者和捐贈者的感染率進行評估。
結果：在 151 個同種異體股骨頭中，共有 94 個未受感染的被用作移植。14 個股骨頭（9.3%）在截取後出現陽性培養結果而遭棄置，而在 94 個在骨庫裏待移植的股骨頭中，有 4 個（4.2%）在植入後對微生物感染測試呈陽性反應，但在病人身上卻沒有出現感染徵狀。有 3 名（3.2%）病人在植入貯於骨庫的股骨頭後出現傷口感染，但這些股骨頭之前對感染測試呈陰性反應。
結論：存於移植中心的股骨頭感染率和接受移植病人的傷口感染率都屬偏低。對骨的活組織樣本進行培養，是監測同種異體骨有否出現微生物感染的一種可靠方法。不過，從貯存在骨庫裏的股骨頭感染率來看，外科部門有必要檢討處理用作移植的同種異體骨的程序，把感染機會減至最低。

Key words:
Bone banks;
Bone transplantation;
Femur head;
Freezing

關鍵詞：
骨庫；
骨移植；
股骨頭；
冷凍

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Introduction

Allografts are frequently used in orthopaedic procedures. However, contamination is a common problem during the retrieval of the graft from donor and graft handling procedure. The reported contamination rate ranges from 1% to 37%,[1-8] depending on the source and method used to culture the micro-organism.

Donor selection criteria

History
No malignancy, autoimmune disease, hepatitis, tuberculosis, and drug addiction

Blood test
Negative for blood culture, Venereal Disease Research Laboratory test, hepatitis B surface antigen, anti–hepatitis C virus antibodies, anti–human immunodeficiency virus type III antibodies, and bone culture

X-ray
No severe osteoporosis

The bone bank of the United Christian Hospital was established in 1994 to provide human femoral head allografts for orthopaedic procedures. This is the first review from the bone bank since it was established. The aim of this study was to evaluate the infection rate of allografts during surgical retrieval and after storage.

Methods

Between January 1994 and March 2000, femoral head allografts were obtained from a total of 151 patients (33 men and 118 women) aged between 61 and 95 years (mean age, 75 years), who had a fractured neck of the femur. Informed consent was obtained, and a detailed history was taken to exclude malignancy and infectious diseases. Blood and bone samples were also taken to detect any infectious diseases; allografts from patients with an infection were discarded. The Box lists the selection criteria.

The femoral heads were retrieved under aseptic conditions. Furthermore, a prophylactic antibiotic (cefuroxime, 1.5 g) was given as soon as the patient was anaesthetised. General or spinal anaesthesia was used. The graft was removed, wrapped in a sterile latex glove for protection, placed into a sterile stainless steel container, which was sealed tightly, and stored in a freezer at -80°C. During graft retrieval, three bone tissue biopsy samples were taken: two for culture of aerobic and anaerobic micro-organisms in blood agar, MacConkey agar, and neomycin blood agar, and one for tuberculosis testing in Lowenstein-Jensen medium. All the specimens were processed in a class II safety cabinet to minimise the chance of microbial contamination.

All the blood test results and bone culture results at retrieval were documented in donors' bone bank records, which were checked by our senior medical officer. The allografts that failed the selection criteria or were found to be contaminated would be discarded. Those that passed the screening tests were transferred to another freezer ready for use. Before the graft implantation, another bone tissue sample was taken to detect any microbial contamination after storage. All recipients were followed up in the out-patient clinic to detect any clinical infection. This verified the reliability of using bone biopsy culture to detect clinically relevant contamination.

Table 1. Bacteriology of the contaminated grafts (n=14) at retrieval*

Organism	No. of grafts
Staphylococcus epidermidis	10
Staphylococcus aureus	3
Clostridium perfringens	1
Acinetobacter anitratus	1
Pseudomonas species	1
Corynebacterium species	1

* Some grafts contain more than one micro-organism

Results

Of the 151 removed femoral heads, 44% were from the right side and 56% from the left side. A total of 94 non-contaminated allografts were implanted by the end of the study: 32 for revision total hip arthroplasty, 8 for primary total hip-and-knee arthroplasty, 11 for spinal fusion, 4 for fixation of upper-limb fracture, 19 for lower-limb fracture, and 7 for tumour surgery. For the remaining 13 allografts, which were not categorised in the above group, were used for miscellaneous surgeries.

Thirty-six of the 151 allografts failed the blood screening tests and were thus discarded. At retrieval, 14 allografts were positive for at least one micro-organism, giving an overall contamination rate of 9.3%. The majority of these allografts were contaminated with bacteria commonly found on the skin (Table 1). These allografts were also discarded. For the remaining 101 allografts, only 94 were used at the end of this study and 7 were still stored in the bone bank.

Four (4.3%) of the 94 allografts were positive for bacterial contamination after storage. However, these grafts were sampled for culture tests just before implantation, and they had already been implanted before the culture results were available. The culture studies revealed scanty growth of *Staphylococcus aureus*. Fortunately, the four patients who received the contaminated grafts did not have any clinical postoperative infections: they had received prophylactic antibiotics, including 1.5 g cefuroxime for the procedure and two doses of 750 mg cefuroxime postoperatively. Other allografts were also tested for any contamination before implanted to recipients.

Ninety-four allografts were implanted to 81 recipients (more than one allograft were used by some patients), of whom 46 are male and 35 are female. Mean age was 51.5 years (range, 11-84 years). All recipients were followed up for 2 to 72 months. Three (3.2%) patients developed postoperative infections: two were superficial wound infections and the other was deep infection. These three patients had not received any contaminated allografts. In

Table 2. Published contamination rate from live donor

Study	Contamination rate (%)	Specimen
Ivory and Thomas[1]	1.2	Bone swab
Tomford et al[3]	11.8	Bone swab
Tomford et al[4]	2.6	Bone swab
Hart et al[6]	2.2	Bone swab
Kakaiya and Jackson[7]	17	Joint swab or bone biopsy
Saies and Davidson[8]	17	Joint swab and bone biopsy
Sommerville et al[9]	22	Bone swab, joint swab, bone biopsy, and capsular tissue
Sommerville et al[9]	12.9	Bone biopsy
Present study	9.3	Bone biopsy

one of the cases of superficial infection, a 67-year-old woman had received an allograft during the arthrodesis of an infected total knee replacement. One month after surgery, there was a 2-cm gap wound and a yellowish discharge. Culture of a swab taken from the wound revealed the presence of *S aureus*. The infection was controlled with antibiotics: cloxacillin 1 g intravenous every 6 hours for 2 weeks and oral ofloxacin for 2 weeks. In the second case, a 67-year-old man had received an allograft to revise a total hip replacement because of the loosening of the femoral stem. Nine days postoperatively, there was a persistent discharge from the wound, together with the appearance of a small gap. Debridement and drainage were performed to remove 5 mL of pus from the subcutaneous plane. Culture of the pus resulted in the growths of *Peptostreptococcus* and *Bacteroides* organisms. The infections were controlled with intravenous vancomycin (500 mg every 8 hours) and metronidazole (Flagyl 500 mg every 8 hours). The third patient who developed an infection was a 40-year-old man who had an allograft implant for the reconstruction of a Schatzker type VI tibial plateau fracture. One month postoperatively, there was erythema and wound discharge. The implant was thus removed and debridement was performed; a total of 10 mL of pus was drained. Culture of the pus yielded a scanty growth of *S aureus*, which was sensitive to cloxacillin. It was in vitro and cloxacillin intravenous every 6 hours was given. None of the other patients had any clinical infections.

Among the 14 allografts showing positive bone culture at retrieval, only one (7.1%) was found wound infection. One of the infected donors—a 64-year-old man with history of diabetes mellitus—whose pus was collected beneath the gluteus maximus muscle. His femoral head had been retrieved during an Austin-Moore hemi-arthroplasty for the fracture of the right neck of his femur. Culture of a bone sample at retrieval showed scanty growths of *Staplylococcus epidermidis* and methicillin-resistant *S aureus*. He died of septicaemia despite intravenous antibiotic therapy and wound debridement. No donors of the bone grafts that was tested negative for micro-organisms at retrieval developed any postoperative wound infections. The Fig shows a summary of the study design and the results.

Discussion

In our study, the contamination rate of allografts during harvest of the femoral heads was 9.3%. Table 2 shows a comparison of rates in other centres. There are several methods used to obtain culture specimens, such as surface swab, joint swab, and bone or tissue biopsy. Different methods accounted for differences in contamination rates. Sommerville et al[9] in 2000 demonstrated that the more specimens are taken, the higher the contamination rate will be. However, it is unclear whether the results after the use of multiple specimens reflect the true contamination rates. In our study, in which only bone biopsies were performed, only 3.2% of allograft recipients developed clinically significant wound infections. This rate is similar to, if not lower than, rates in other reported studies (6.9%-12.2%).[1,10,11] Taylor et al[12] reported the infection rate associated with different kinds of orthopaedic procedures in Winford Orthopaedic Hospital, Bristol, Avon—for example, 4.5% during revision total hip arthroplasty and 5.7% during spinal fusion and primary knee arthroplasty. The similar infection rates suggest that postoperative wound infections cannot be totally attributed to the use of an allograft. On the basis on these results, it is reasonable to suggest that the use of bone biopsy alone is a reliable approach to detect microbial contamination of bone grafts at retrieval.

In our study, four (4.3%) patients received bone grafts that were found to be contaminated with *S aureus* after storage. All four patients did not subsequently have any clinical infections. The concentration of bacteria in the bone culture was low, and the infection was controlled by antibiotic therapy. Sometimes the use of postoperative dosage would be prolonged depending on the clinical condition. Also, the patient's own defence mechanism helped to prevent the infection. For those with positive culture after storage, antibiotics would be given according to antibiotic sensitivity. Three-week intravenous followed by 3-week oral antibiotic treatments were given. There have been reports of similar situations.[1,6,9] Thus, the bone biopsy culture of the stored allograft is important, because it provides information on antibiotic sensitivity in case subsequent clinical infections arise.

The wound infection rate and contamination rate at retrieval were 7.1% and 9.3%, respectively. No wound infection was reported in non-contaminated allografts. Because the infection rate of contaminated allografts was greater than that of non-contaminated ones at retrieval, it is suggested that the main source of contamination is during the operative procedure. Still, the fact that the recipients of grafts that were contaminated during storage did not develop any clinical infection does not mean that contamination after storage is not important. The relevance of this contamination in the stored allografts warrants further evaluation. Some authors have proposed that all bone grafts be irradiated to prevent infection.[1,5,9] We are not using

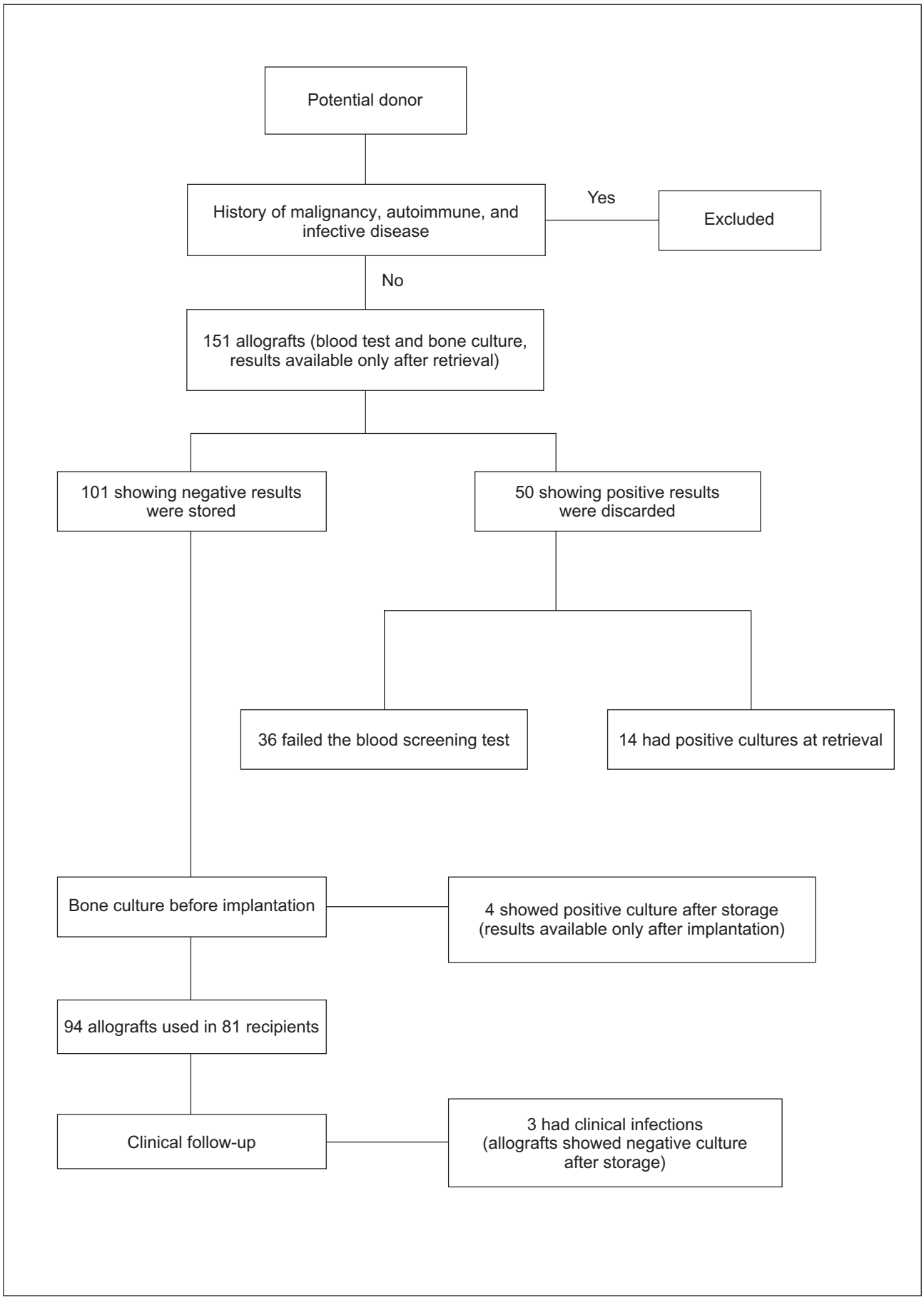

Fig. Summary of the study design and results

this method in our hospital, because we have a low infection rate after implantation of the allograft and there may also be a loss of osteo-inductive effect after irradiation.[13,14]

Conclusion

It is suitable to use bone biopsy alone as a means of detecting clinically relevant contamination of bone grafts at retrieval. The possibility of contamination during bone graft handling should prompt us to develop an optimal handling technique. We suggest a regular audit of the skin preparation technique, scrub-up procedure, and graft handling methods so as to reduce the chances of graft contamination.

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