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Suction tip contamination in the ultraclean-air operating theatre

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The surgical suction tip forms a reservoir for microorganisms during total hip replacement in conventional operating theatres. We assessed the colonisation of the tip in an ultraclean-air operating theatre in 39 patients, and found that 41% of them had evidence of bacterial colonisation with one or more bacteria. To avoid contamination we suggest that the suction tip is changed before preparation of the femoral canal and insertion of cement and prosthesis.

An integral part of many operative procedures is the suction system used to clear blood and other debris. Large volumes of air are sucked through the sucker, which is placed in intimate contact with the femoral shaft and acetabulum before the implantation of the bone cement and prosthetic components.

It has been suggested that this system used during total hip arthroplasty is a potential source of wound infection. Microorganisms were isolated from 11 of 30 sucker tips by Greenough *(1)*, and 13 of 20 by Meals and Knoke *(2)*. However, the previous studies were carried out in conventional operating theatres in which the incidence of joint sepsis is twice that seen in ultraclean-air operating theatres *(3)*. Accordingly, a study was carried out in an ultraclean-air operating theatre utilising a laminar flow system in which there is a rapid throughput of air in a vertical direction, and change of the theatre atmosphere 300 times per hour. The aim was to establish whether bacterial contamination of the sucker tip still occurred during total hip replacement, and to attempt to characterise the microorganisms and their source.

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Materials and methods

A total of 39 procedures was studied, all of which were primary total hip replacements with no previous surgery or sepsis at the operative site.

At induction all patients received antibiotic prophylaxis of amoxycillin 1 g and flucloxacillin 1 g intravenously. The operations were performed in the semilateral position with a large sandbag supporting the buttock to allow access to the hip.

All operations were performed in the same Charnley-Howarth vertical laminar flow operating theatre, which was a designated orthopaedic theatre. The surgeons wore conventional, but non-permeable, theatre gowns, surgical hoods, face masks and two pairs of gloves. The skin was prepared with chlorhexidine in 70% alcohol. A plastic adhesive drape was applied before incision.

A sterile disposable Yankauer sucker was connected to the suction bottle at the beginning of the operation and was left aspirating continuously until the end. This 'active' sucker was kept in the diathermy quiver when not in use. A second 'control' sucker was left in a separate quiver on the operating table, it was cultured to validate the microbiological technique and exclude the possibility of inadvertent contamination.

At the end of the operation the distal 3 cm of the sucker tips were cut off and placed in separate sterile bottles containing 20 ml of nutrient broth (Oxoid nutrient broth Number 2, 25 g/l). These were sent immediately to the microbiology department where they were vigorously rotated for 30 s. A 0.2 ml aliquot from each bottle was then plated onto three types of culture media, blood agar, chocolatised blood agar and cystine, lactose, electrolyte deficient agar (CLED, Oxoid). The CLED and chocolate agar were incubated at 37°C in air and 10% CO_2; the blood agar was incubated anaerobically with 10% CO_2 at 37°C. The remaining broth and suction tip were incubated at 37°C for a total of 2 weeks, with 0.1 ml aliquots plated out at 48 h and 5 days onto blood agar, chocolate agar and CLED as above. In addition 0.1 ml aliquots were similarly plated out at the first sign of any bacterial growth which occurred during this 2-week period of incubation. Species were identified using standard methods *(4)*. Micrococci and Staphylococci were distinguished on the basis of lysostaphin and bacitracin resistance.

Air sampling

In the operating theatre a Biotest RCS® centrifugal air sampler was placed on the floor beneath the patient's head. The standard height for air sampling during operations is approximately equal to that of the operating table, this tests the central clean area. The peripheral dirty areas of the theatre are then tested. In order to maximise the operative yield of microorganisms in this study, and hence improve comparison with the sucker isolates, the sampler was placed 30 cm above ground level, beneath the ventilation hood and directly in the 'outflow' airstream from the operating table and staff. This enabled us to obtain a greater catch of organisms. The sampler was switched on for a period of 8 min during the period when the femoral shaft was being prepared. Nutrient agar strips were then incubated at 30°C for 48 h. Calculation of the number of colony-forming units per cubic metre (CFU/m^3) of air was performed using the modified methodology for the Biotest air sampler *(5)*.

Sampling was performed in the empty operating theatre before the start of the operating list, as well as peroperatively. A total of eight preoperative and 19 peroperative samples was taken.

Results

Of the 39 cases, 16 (41.0%) showed bacterial contamination of the 'active' sucker tip. Of these, 9 (23.1%) showed contamination with one organism, 4 (10.3%) showed contamination with two organisms and 3 (7.7%) with three organisms (Table I). This gives a total of 26 isolates in 16 patients, the distribution of organism types is shown in Table II. In a single case a coagulase negative staphylococcus was grown from the 'control' suction tip; this did not correspond with the organism grown from the 'active' tip.

Table I. Total number of organisms isolated

Number of isolates	*% Suction tips*
0	59.0
1	23.1
2	10.3
3	7.7

Table II. Percentage of isolates from sucker tip

	% Isolates
Staphylococcus aureus	3.9
Coagulase negative Staph.	34.6
Micrococci	15.4
Grp. B Streptococci	3.9
Non-haemolytic Streptococci	3.9
Enterococci	3.9
Escherichia coli	3.9
Proteus spp	3.9
Diphtheroids	26.9

The bacterial growth did not occur in any case from the original plating out of the broth, but only on subsequent subculture after it had been allowed to grow over a 2-week period. This suggests that the total number of organisms on the tip is low.

The air sampling yielded isolates of Micrococcus spp., Bacillus spp., coagulase negative Staphylococci and Diphtheroids. The preoperative air sampling yielded counts of less than 10 CFU/m^3. The perioperative samples ranged from 12–20 CFU/m^3. There was no direct correlation between the organisms isolated on air sampling and those from the sucker tips, after biotyping and antibiogram had been compared.

Discussion

The observation that the sucker tip may form a reservoir for pathogenic organisms has been made previously *(1,2)*. This is of considerable concern, particularly as the sucker is inserted into the femoral canal before implantation of bone cement. As Lidwell *et al. (3)* has found much lower bacterial counts in wound washout studies in ultraclean-air as opposed to conventional operating theatres, we thought that contamination of the suction tip would be negligible. However, sucker tip contamination proved to be as frequent as in a conventional operating theatre. Whyte *et al. (6)*, in a study on similar operations, has shown that airborne spread is the most important source of wound contamination. This suggests that the source of the organisms is shedding from the

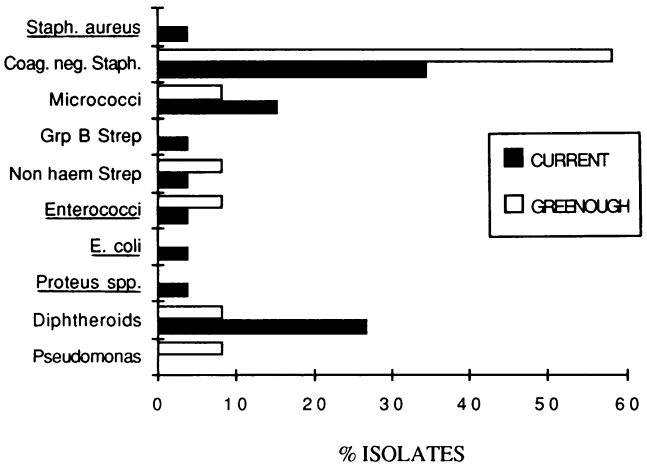

Figure 1. Incidence of isolates in current study compared with Greenough *(1)*.

surgical team or the patient. This is supported by the spectrum of species isolated in this study (such as coagulase negative Staphylococci and Diphtheroids).

Despite the similarity in species type in our ultraclean-air theatre and Greenough's conventional theatre, we found a wider range of organisms (Fig. 1). This range could reflect the fact that we took the last 3 cm, rather than 2 cm of the suction tip, and also the slight differences in culture technique. In the absence of isolates from our 'control' tips, they are most unlikely to reflect contamination. Antibiotic prophylaxis may also affect the range of microorganisms cultured. This would seem unlikely in this study, as Taylor *(7)* found little change in the spectrum of infective organisms cultured in patients requiring a revision total hip replacement for infection, whether antibiotic prophylaxis had been used or not.

The patients have been followed up for a period of between 6 and 12 months and no superficial or deep infections have been observed. Nevertheless, the findings are worrying. The proportion and range of organisms found were similar to those isolated at revision total hip replacements undertaken for infection. For example, the coagulase negative Staphylococci which were isolated from 34.6% of the sucker tips are implicated in 40–50% of prosthetic infections *(8,9)*.

The absolute number of organisms contaminating the suction tip must be small, as immediate plating out of the broth was uniformly negative. However, one cannot draw conclusions regarding the numbers of pathogens on the tip as they have differing growth rates. In the light of the MRC trial *(3)* demonstrating that most wounds are contaminated, but that light contamination may not lead to clinical infection, it may be that the risk of subsequent clinical sepsis from a contaminated catheter tip is more theoretical than real. However, we are not so concerned with wound infection, as with deep prosthetic infection.

Wound washout studies have demonstrated that contamination of the wound is much reduced by using body exhaust suits as well as the vertical clean air enclosures used here. It would therefore be of great interest to repeat this investigation in an operating theatre employing such suits.

In conclusions, we have demonstrated that even in ultraclean-air operating theatres the suction catheter forms a focus for those organisms which have been implicated in septic loosening of hip prostheses. While colonisation does not equate with infection, we suggest the use of a fresh and sterile catheter for the preparation of the femoral canal before implantation of cement and prosthesis during total hip replacement.

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