Optimal Timing of Wound Drain Removal Following Total Joint Arthroplasty

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Abstract: Closed suction drains reduce postoperative hematoma formation, but create an entry portal for bacteria and thus increase the risk of infection. This study attempts to establish when the risks of wound drainage outweigh the benefits. In a prospective clinical trial, wound drains were used in all patients having a total knee or total hip arthroplasty. Timing of drain removal and amount drained were recorded. Drain-site swabs were sent with drain tips for bacteriology. Results suggest that the likelihood of bacterial colonization increases while wound drainage decreases with time. The authors conclude that the optimal time to remove drains is 24 hours after total joint arthroplasty. **Key words:** total joint arthroplasty, drain, infection, timing, removal.

Closed suction drainage of wounds has been well established as a principle of management following joint arthroplasty. More recently, the efficacy of this practice has been questioned.[1,3] The use of closed suction drains is now considered controversial.

Prospective quantitative work by Magnussen et al.[4,5] using ultrasound to detect wound hematoma established significant correlation between hematoma formation and perioperative wound complications. Based on this premise, combined with previous findings that show that drains will reduce hematoma formation[8] but increase infection risk,[6,7] we think that drains should be used if removed at the appropriate time after surgery.

Little has been written to guide the surgeon with regard to how long the drain should remain *in situ*. This has commonly been limited to instructions such as remove drains once drainage has ceased or becomes insignificant resulting in removal from 24 to 72 hours after surgery.[8,9]

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Willett et al.[10] showed that the benefit of reducing hematoma formation is lost after 24 hours and suggested that skin microorganisms will ingress to the wound via the drain after 24 hours. This study attempts to confirm such findings.

Materials and Methods

In a dual-center prospective clinical trial, patients undergoing total hip or total knee arthroplasty were selected between April and December 1990. Surgery was performed by the orthopaedic surgeons of St. Vincent's Clinic, in either St. Vincent's General Hospital or St. Vincent's Private Hospital. Surgeries took place in standard operating theaters without laminar air flow. Surgeons were asked to randomly allocate the time that the drains were left *in situ* after surgery.

Perioperative care was standard for all patients. The prophylactic antibiotics used were gentamicin (80 mg twice or three times a day intravenously) and flucloxacillin (1 g four times a day intravenously). The drugs were administered during surgery and continued for 48 hours after surgery. Deep venous thrombosis prophylaxis consisted of antiembolism stock-

Table 1. Wound Drainage Characteristics

	Hips				Knees			
Time Interval (hours)	No. of Patients	Mean Drainage (mL)	Range (mL)	Proportion of Total (%)	No. of Patients	Mean Drainage (mL)	Range (mL)	Proportion of Total (%)
0–24	63	583	240–1,865	67	29	608	190–1,395	76
24–48	56	167	10–770	19	21	142	10–740	18
48–72	33	75	10–210	9	6	48	10–110	6
72–96	8	45	5–120	5				

ings, and subcutaneous heparin and spinal anesthesia was used in most cases.

Any patient with a medical condition or drug therapy that was likely to influence bleeding was excluded from the study.

Forty-nine men and 43 women were entered into the study for a total of 92 patients. The mean age was 67 years (range, 26–86 years). Sixty-three patients had total hip arthroplasties (THAs), 9 of which were revisions, while 29 patients had total knee arthroplasties (TKAs), 3 of which were revisions. Fifty-one procedures were performed at St. Vincent's General Hospital and 41 were performed at St. Vincent's Private Hospital. Chief etiologies included osteoarthritis, rheumatoid arthritis, loose components, and avascular necrosis. There were 1 or 2 deep drains per case for a total of 164 drains.

Drains were 1.9 mm in external diameter, with 60 mL reservoirs, each of which exerted 100 mmHg suction pressure as the reservoir filled. The drains were clamped when reservoirs were changed. Drains were randomly left *in situ*, some for up to 96 hours, and were grouped according to the period in which they were removed. Drainage was quantified in each 24-hour period until removal.

On removal of the drain, a bacteriology swab was taken from the site where the drain perforated the skin. This was sent along with the drain tip for microscopy and culture. All revision joints were routinely swabbed at operation; any positive results were excluded from the study. For each 24-hour period, the mean blood loss and number of drain tips that had become contaminated were recorded.

The initial step in specimen collection was a bacteriology swab at the drain site. The site was then cleaned with an iodine solution. Drains were then removed using an aseptic technique. Tips were cut with sterile scissors and dropped into sterile containers. In the microbiology laboratory, tips were taken out of containers with sterile forceps, rolled four times on a blood agar plate, and then dropped into a cooked meat nutrient broth (which also contained a reducing agent). The plate and broth were incubated for 5 days after which a report was made. Drain-site swabs were rolled on blood agar and McConkey agar plates, which were also incubated for 5 days. Microorganisms were identified using the Analytical Profile Index system and antibiotic sensitivities.

Results

Mean wound drainage decreased with time (Table 1). Quantities were similar for THAs when compared with TKAs. For both groups, the most drainage occurred in the first 24 hours (67% for hips and 76% for knees).

In 29 patients, at least one specimen revealed a microorganism when cultured (Table 2). In four patients, positive cultures were from the drain site only, and in six patients, the drain tip and corresponding site cultured identical organisms.

In 19 patients, positive cultures were from the

Table 2. Microorganisms Isolated

Drain Site Only (4 patients)	Drain Site and Corresponding Tip (6 patients)	Drain Tip Only: Plate and Broth (5 patients)	Drain Tip Only: Broth Only (14 patients)
Staphylococcus epidermidis (2 patients)	*Staphylococcus epidermidis* (3 patients)	*Staphylococcus epidermidis* (5 patients)	*Staphylococcus epidermidis* (11 patients)
Coliform bacilli (2 patients)	*Klebsiella pneumoniae*	*Klebsiella pneumoniae*	Coliform bacilli (2 patients)
	Staphylococcus aureus		*Staphylococcus aureus*
	Diphtheroid sp.		Streptococcus group D
			Diphtheroid sp.
			Actinomyces israelii

Table 3. Wound Drain Contamination

Time Interval (hours)	Hips			Knees		
	No. of Deep Drains	No. of Contaminated	Percent Contaminated	No. of Deep Drains	No. of Contaminated	Percent Contaminated
0–24	9	0	0	11	1	9
24–48	43	8	18	28	5	19
48–72	46	10	23	11	2	17
72–96	16	3	18			

drain tip only; two deep drains were positive for the same patient in four of these cases. This created a group of 23 drain tips. In 6 of these, microorganisms were identified from the agar plate and nutrient broth, while for the remaining 17 drain tips, microorganisms were identified from the nutrient broth only.

One of the positive cultures was from a drain tip that had been removed within the first 24 hours after surgery. The remaining positive cultures were all from specimens taken after that time. The proportion of drains contaminated after 24 hours was significantly higher (Table 3).

Discussion

These results support previous findings[8,10] that the majority of wound drainage will occur within the first 24-hour period after surgery. In this study, approximately 70% of the mean total drainage had occurred by then.

Work by Waugh and Stinchfield[8] showed that continued suction promotes bleeding and that most active bleeding is normally ceased after 12 hours. Browett et al.[11] looked at the contents of drainage (albeit following meniscectomy) and showed that after 48 hours only 8% was blood. Willett et al.,[10] in their study of THA, found 91% of mean drainage to have occurred by 24 hours after surgery. We also find drain removal after 24 hours reasonable on a purely quantitative basis.

Moreover, removal as early as 24 hours is a matter of great importance on the basis of culture results. There is a marked increase in the frequency of contaminated drain tips after 24 hours for both THA and TKA, although the difference is not statistically significant ($.1 < P < .25$). A fall in mean wound drainage thus clearly contrasts with a rise in drain-tip contamination at 24 hours, as illustrated in Figures 1 and 2. Studies by Waugh and Stinchfield[8] and Willett et al.[10] recommended early drain removal on similar grounds.

The source of drain-tip contamination is not clear. Our results suggest that deep wound drains may become contaminated in several ways.

Cerise et al.[12] have proven that if the skin around a drain site is contaminated, microorganisms can migrate along the drain surface to the deep part of the wound. This is the likely mode of contamination in those six patients for whom the drain tip and corresponding site revealed identical microorganisms. The four patients with drain-site contamination only are evidence that ingression of microorganisms will not necessarily occur before drain removal.

Casey,[13] in 1971, showed that microorganisms may migrate within the lumen of a wound drain. We think that this is a possible mode of contamination with reference to those 17 contaminated drain tips from which microorganisms were isolated in nutrient broth only. In only one of these cases was the organism an anaerobe (*Actinomyces israelii*), which could not have grown on the agar plate. The remaining microorganisms may only have existed in the lumen and thus not have inoculated the agar when the drain tip was rolled across it. Retrograde intralumenal migration of bacteria along the deep drain is thus postulated as a significant risk factor in deep wound sepsis following total joint anthroplasty. A wound drain lumen may be contaminated at an initial reservoir connection or during reservoir changes. We accept that more accurate data would

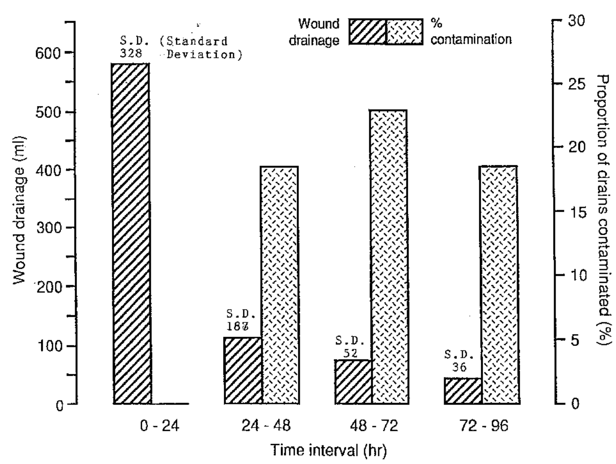

Fig. 1. Mean wound drainage and drain-tip contamination for hips.

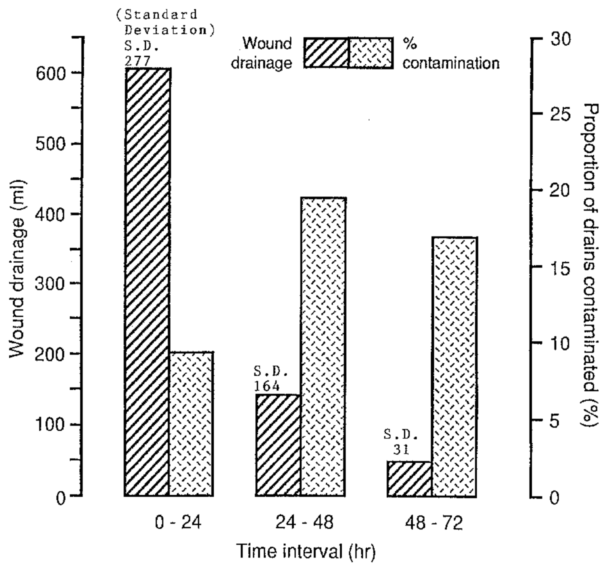

Fig. 2. Mean wound drainage and drain-tip contamination for knees.

have been obtained had we separately cultured the lumen contents.

Microorganisms were isolated from the surfaces of the remaining contaminated drain tips whose corresponding drain sites were sterile. We suggest that intraoperative contamination may have occurred.

Conceded is the possibility of specimen contamination during collection and transport. Our series of 164 deep drains revealed 17.7% contamination of drain tips, which compares favorably with Waugh and Stinchfield's[8] 17%, although it is somewhat higher than the 5.8% reported by Willet et al.[10] The high proportion of *Staphylococcus epidermidis* does not surprise us as this organism is currently recognized as the most frequent pathogen in prosthetic joint infections.[14]

While no study exists correlating wound drain contamination directly with early or late wound infection, previous work by Cruse and Foord[6] and Simchen et al.[7] shows an increased rate of infection in clean, closed suction drained wounds as compared to nondrained control wounds. These findings together with our results ensure that wound drains are highly implicated in the potential pathogenesis of wound infection. If a drain is removed more than 24 hours after surgery, we believe that routine culture of the tip would be a worthwhile procedure to determine the presence of potential pathogens.

Prophylactic antibiotics should be used while drains are *in situ*. Nelson et al.[15] studied the concentration of antibiotics in wound contents and reported that it decreased steadily with time in spite of consistent intravenous dosage levels. This decrease is quite dependent on initial clot levels that, if suboptimal, lead to a rapid decline in the minimum inhibitory concentration in wound contents. Effective antibiotic prophylaxis thus progressively decreases with time; a finding that reinforces the idea of early drain removal.

In summary, this study advocates the use of drains to prevent infection and perioperative wound morbidity by reducing hematoma formation while also demonstrating that the drains themselves are a significant infection risk. The answer to this paradox lies in the removal of the drains when the benefit of hematoma prevention is outweighed by the risk of wound contamination.

The findings of this study suggest that drains should, in most cases, be removed 24 hours after joint anthroplasty.

Other recommendations derived from this research include the use of prophylactic antibiotics at least until drain removal and routine culture of all drain tips following delayed drain removal.

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