# SURGICAL SEPSIS

edited by
Colin J. L. Strachan
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# Preface

This symposium was designed to provide a platform for the review and discussion of methods in current vogue for the prevention of abdominal wound sepsis.

The speakers were chosen for their recent contributions which had advanced our state of knowledge of the factors involved in wound sepsis in recent years. Their topics range from the mundane, but still deadly, "hot appendix" to the more esoteric and, until recently, poorly understood syndrome of pseudomembranous colitis. "Inner cleanliness" is now thought to be more important than exogenous contamination in abdominal surgery and this has revised our thinking on the prophylactic use of antibiotics.

We have come a long way from the Medical Research Council's recommendation that "while dressings are in progress no talking is allowed and all unnecessary movement is prohibited" (Illingworth, 1943). Chemoprophylaxis of surgical infection has emerged from the disrepute of emotional overprescription to become clinical practice in many centres. Controversy, as will be apparent, still exists over the choice of agents for particular conditions.

The changes seen over recent years are due in no small measure to the contributions from the groups led by the two co-chairmen of this symposium. Mr John Alexander Williams of Birmingham and Mr Alan Pollock of Scarborough. We are also indebted to Professor Harlan Stone who made the long trip from Atlanta in Georgia. As the organisers of this meeting we should like to congratulate Lilly Industries of Basingstoke UK for their support and particularly the help given by Dr Kevin Woodcock and Mrs P. Bramble of the Medical Department. For her secretarial services in collating the chapters of this book and checking references we are particularly indebted to Mrs Dorothy Hammond of the Microbiology Department, Dudley Road Hospital, Birmingham. Lastly we are greatly indebted to Dr John Garvey of the Nuffield Department of Surgery, Radcliffe Infirmary, Oxford for compiling the index.

C.J.L.S.
R.W.

January, 1979

# Contents

# 1. Introduction

J. ALEXANDER-WILLIAMS

Sepsis is a slight upon surgical virility. Surgeons do not like to admit that their cases have septic complications. If sepsis should occur in their cases, they like to believe that it is of little consequence, does not prolong hospital stay and can be dealt with by the district nurse anyway! Because of this attitude surgeons tend to underestimate the size and severity of the problem of postoperative sepsis and have been slow to study means of prevention.

It is possible that in the past surgeons attempting prospective controlled studies were so ashamed of their own control figures that much good work remained unpublished. It was not until some courageous registrars, emboldened by the wind of liberal change blowing through the hallowed halls, began to publish figures with very high infection rates (Polk and Lopez-Mayor, 1969; Jackson *et al.*, 1971; Burton, 1973) that it became respectable to admit to a high rate of infection; particularly after colonic operations. It is really only in the last decade that the subject has become respectable. If you review the subject indices of surgical journals of ten years ago you find scant mention of antibiotics, microflora or sepsis. Now these words abound and are even joined by that new word that we have come to discuss today, prophylaxis. The first four articles in a recent issue of the *British Journal of Surgery* were on microbiology or prophylaxis. Since distinguished figures such as Dr Harlan Stone and his colleagues (1976) began to convert sepsis into dollars, research on prophylactic methods has accelerated. Dr Stone showed that the cost of an infected wound was about $12 000 so that even the administrators sat up and took notice. In this book the state of the art of preventing wound sepsis is presented through the eyes of some of the distinguished leaders of the field in Britain and a world authority, Dr Harlan Stone, who gives the North American viewpoint.

It has been said that the risk of infection is related to the virulence of the organism on the one hand and the resistance of the patient on the other. This concept is too basic and ignores such important factors as the size of the inoculum, the mix of organisms, the presence of other foreign material and the different resistance of different tissues. As an example of the last variable note how difficult it is to infect the lip, the heart or skeletal muscle and how easy to infect fat.

There are reviews of the achievements of the past ten years and the discussion which these reviews provoked. It is interesting to note that in the commonest cause of abdominal sepsis, appendicitis, the participants had no common view and a lively debate ensued.

We have collected what we know now about how to reduce the size of the inoculum, how to strangle the inoculum at birth, how and when to bathe the receptive susceptible tissues with appropriate antimicrobial drugs, the dangers of inappropriate and appropriate prophylactic drugs, what to do when operating in the face of sepsis, and possibly Dr Stone has also gladdened our hearts by emphasizing the cost effectiveness of appropriate prophylaxis.

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# 2. Abdominal Wound Protection by Means of Plastic Drapes

M. H. WHEELER

Wound infection continues to be a significant complication of surgery particularly following procedures on the large bowel. Although wound infection is rarely lethal it causes considerable patient discomfort and has important economic implications with regard to length of hospital stay and patient recovery time. In the majority of cases the organisms causing infection are introduced into the wound at the time of surgery. Potent sources of these organisms include the patient's own skin, the patient's alimentary tract, members of the surgical team and the operating theatre atmosphere.

Two obvious approaches to this problem are: (a) to destroy organisms which have already reached the wound; (b) to prevent the organisms reaching the wound in the first place. The first approach involves the administration of either systemic or local antibiotics. Over the years many techniques have been employed in order to minimize the numbers of organisms reaching the surgical wound and causing contamination.

Traditionally linen and cloth towels have been placed on the skin surrounding the operative field to protect the wound by exclusion. Unfortunately such towels are likely to be ineffective as they do not protect the wound surfaces from within as they become moist and contaminated as a result of haemorrhage and spillage of infected intraperitoneal fluid. These latter objections also apply to permeable wound guards actually placed in contact with the raw wound surfaces.

Sterile adhesive plastic skin drapes were introduced almost 20 years ago (Artz *et al.*, 1960; Pace 1960) in order to act as an impervious layer and reduce the passage of bacteria-transporting vehicles such as blood, serum, pus or intestinal contents. But as these drapes act only at a skin level and do not in fact cover the cut wound surface it is no surprise that several studies have failed to demonstrate any advantage with respect to wound infection rate following the use of adhesive drapes (Moreland *et al.*, 1962; Maxwell *et al.*, 1969; Jackson *et al.*, 1971; Cruse and Foord, 1973).

A logical extension of the concept of wound protection came when Cole and Bernard (1967) introduced a plastic ring wound drape which was designed to extend over the edges of the cut wound and thereby protect the raw wound surfaces from contaminating organisms. A theoretical disadvantage of the use of these plastic wound liners is of course the possibility that infected intraperitoneal fluid may track up around the outside of the plastic drape

by capillary action and contaminate the wound. Skin organisms likewise may move in an opposite direction into the wound.

Raahave (1974) showed that these drapes were capable of reducing the bacterial density in potentially contaminated wounds, but proof that the incidence of actual clinical wound infection can be significantly reduced by employing this technique is inconclusive (Harrower, 1968; Ellis *et al.*, 1969; Maxwell *et al.*, 1969; Alexander-Williams *et al.*, 1972).

We have conducted a randomized prospective controlled trial to assess the role of adhesive plastic skin drapes and plastic ring wound protectors, in the prevention of wound infection following abdominal surgery.

There were 144 patients undergoing abdominal surgery included in the main trial (Group A). A standard skin disinfection procedure using 1 in 30 Savlon (chlorhexidine 0.05% and cetrimide 0.5%) and Hibitane spirit (chlorhexidine gluconate 0.5% in alcohol) was employed throughout. Standard linen towels were then applied to the operative area in all patients. Before surgery patients were randomized into two groups to receive either an adhesive plastic drape or a plastic ring wound protector in addition to the standard linen towels. The adhesive skin drape used was Steri-Drape (Minnesota Mining and Manufacturing Co.). This was applied to the skin at the operative site over the linen towels. Vi-Drape (Parke, Davies and Co.) was the plastic wound drape being tested. This was placed through the wound itself, the ring being permitted to expand against the inner peritoneal aspect of the abdominal wall and the drape drawn over the wound surfaces. In a control group linen towels alone were used. At the completion of each operation prior to wound closure bacteriological swabs were taken from the wound edge. All specimens were placed in a transport medium which was taken to the laboratory for immediate aerobic and anaerobic culture. In those patients in whom plastic drapes were employed a small segment of drape adjacent to the wound edge was also taken for bacteriological examination. A standard two-layer method of wound closure, using continuous chromic catgut and monofilament nylon, was employed in the majority of cases. An adhesive dressing was applied to every wound. The wounds were inspected daily after the third postoperative day and at least one of the following criteria was used to identify the presence of infection: (1) erythema around the sutures or along the wound edge with an accompanying pyrexia; (2) discharge of exudate or pus from the wound; (3) wound breakdown. If infection was considered to exist, bacteriological swabs were taken and sent for immediate culture. Patients receiving pre-operative antibiotics (with the exception of non-absorbable sulphonamides used for bowel preparation) were not included in the trial.

In order to explore the possibility that plastic ring drapes effectively protect the abdominal wound during surgery but not in the last few moments of the procedure when the potentially dirty drape is drawn

through the wound and removed, a further small group of eight patients was studied (Group B). A ring drape was inserted into the wound at the start of surgery, and on completion of the procedure two small biopsies of opposite edges of the wound were taken, inserted into transport medium and sent for immediate bacteriological culture. The plastic drape was then removed and a small piece of drape material adjacent to the ring was taken along with a swab of the anterior abdominal wall peritoneum for additional bacteriological culture. When the peritoneal and muscle layers of the abdominal wound had been sutured two further biopsies were taken from opposite edges of the wound for culture.

Ring drapes were also employed in a further small subgroup of 18 patients (Group C) but at the time of insertion of the drape into the wound two gauze packs soaked in Hibitane spirit were placed in the wound, one between each raw cut surface and the plastic drape material. These packs extended beneath the drape onto the skin surrounding the wound. At the end of the surgical procedure two small biopsies of opposite edges of the wound were taken for bacteriological culture. The plastic drape and the Hibitane-soaked packs were then removed, and a small piece of the drape material adjacent to the ring and a swab of the anterior abdominal wall peritoneum taken for additional bacteriological culture. Once the peritoneal layer of the abdominal wound had been sutured two further biopsies were taken for culture from the opposite edges of the wound.

Eighty-two females and 62 males were included in the main section of the trial (Group A). There were 26 cases of wound infection producing an overall wound infection rate of 18%.

## I. Influence of Wound Drapes on Infection Rate

Adhesive drapes were employed in 51 patients and ring drapes in 46. There were 47 patients in the control group. Neither type of plastic drape significantly affected the wound infection rate (Fig. 1). The various surgical procedures were subdivided into the following groups: (1) clean operations, in which the gastrointestinal tract was not opened and pus was absent; (2) potentially contaminated operations in which the gastrointestinal tract and/or the biliary tract were opened; (3) contaminated operations on the colon and rectum.

The use of either type of plastic drape failed to influence the wound infection rate in any of these groups of procedures (Fig. 2). The overall wound infection rates for each of the groups were 10, 12 and 46% respectively. It is no surprise that the infection rate in the colonic and rectal surgery group was significantly greater than that of the other two groups ($\chi^2 = 14.4$, $P < 0.01$).

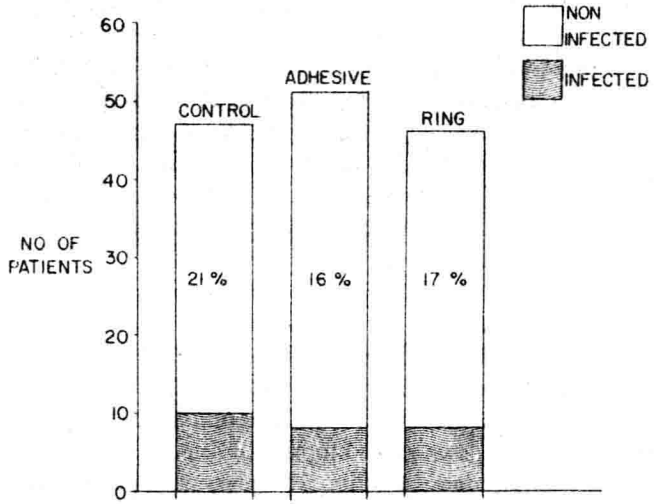


FIGURE 1. Incidence of wound infection in the control, adhesive drape and ring drape groups. Shaded areas indicate wound infection.

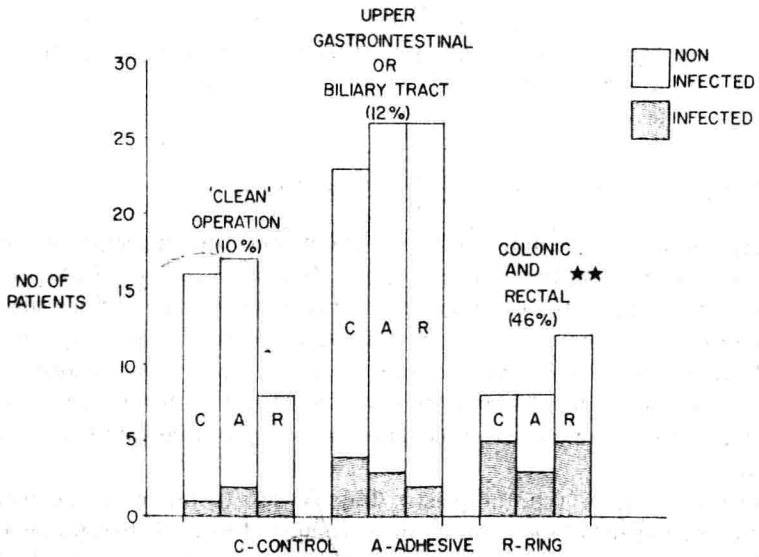


FIGURE 2. The influence of the type of surgical procedure and the use of plastic wound drapes on the incidence of wound infection. Shaded areas indicate wound infections. C, control; A, adhesive drape; R, ring drape. **Significant ($P < 0.01$) difference between wound infection rates in colonic and rectal and control groups.

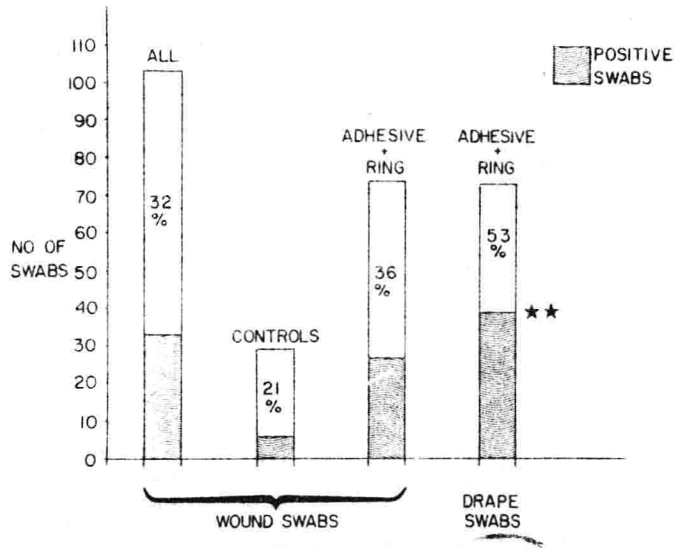


FIGURE 3. The incidence of positive wound and drape swabs. Shaded areas indicate positive bacteriological cultures. **Significant ($P < 0.01$) difference between the positive culture rates in the drape and control groups.

A. Bacteriological Studies

Wound swab information was available on 103 cases. Positive operative wound swabs were obtained in 32% of these patients. This did not differ significantly from the positive swab rate in both the control group and the plastic drape groups. As the results in the adhesive and ring wound drape groups were almost identical these figures have been pooled together for simplicity (Fig. 3).

Bacteriological examination of a piece of the adhesive or ring drape yielded a positive culture rate of 53%. This was significantly greater than the positive wound swab rate in the control group ($\chi^2 = 9.0$, $P < 0.01$).

The operative swab was positive in 68% of those wounds which became infected compared with only 24% of those not developing a wound infection (Fig. 4). Almost identical results were obtained in the control and drape groups and also when the drape material itself was cultured. Of the 33 patients with a positive wound swab there were 13 (39%) who subsequently developed a wound infection (Fig. 5). This contrasts with the wound infection rate of only 8.6% in those with a negative culture ($\chi^2 = 14$, $P < 0.01$). In

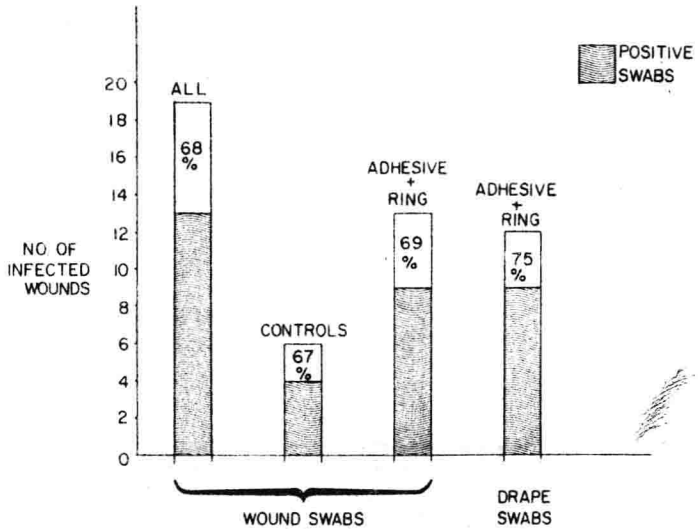


FIGURE 4. The incidence of positive wound and drape swabs in those wounds which subsequently became infected. Shaded areas indicate positive bacteriological cultures.

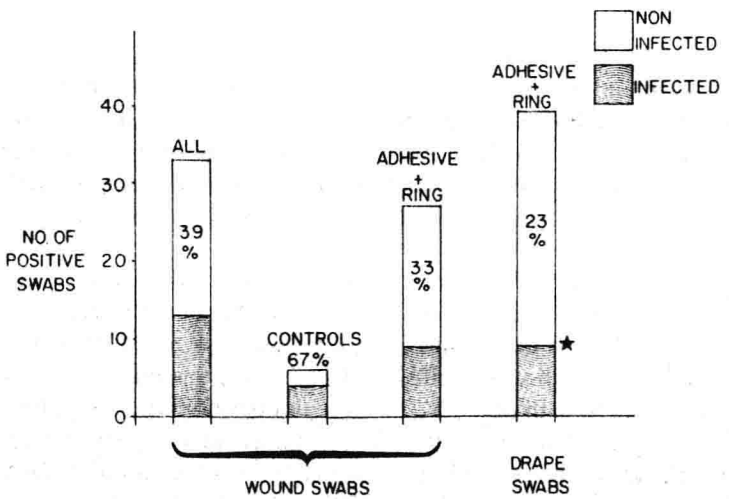


FIGURE 5. The incidence of wound infection in those patients with a positive operative wound or drape swab. Shaded areas indicate wound infections. *Significant ($P < 0.05$) difference between wound infection rates in the drape and control groups.

ten of the 13 cases of infection there was an excellent correlation between the organisms cultured at operation and those subsequently grown from the wound infections. Eight of these ten swabs grew coliform organisms.

In the control subjects 67% of those with a positive operative swab became infected, compared with only 23% of those with a positive culture of the drape material. This difference is significant ($\chi^2 = 4.8$, $P < 0.05$) (Fig. 5).

### B. Bacteriological Studies of the Abdominal Wound Before and After Drape Removal

Skin organisms (*Staphylococcus aureus* and *S. albus*) could be cultured from the cut wound surfaces at the completion of surgery in five of the eight cases examined (Group B) (Table I). Once the drape was removed all the wounds became contaminated with these organisms although only one wound subsequently became infected. Six of the peritoneal swabs also yielded a positive growth of organisms but it is somewhat surprising that culture of the drape material itself was sterile in all but one case.

Clearly ring wound drapes are not capable of keeping either the wound surfaces or the peritoneum sterile and it does appear that some wound contamination takes place between removal of the drape and actual wound closure.

TABLE I

*Bacteriological Examination of Wound and Drape Swabs in Eight Patients*

| Patients | Wound biopsies before drape removal | | Drape swab | Peritoneal swab | Wound biopsies after drape removal | |
|---|---|---|---|---|---|---|
| | 1 | 2 | | | 1 | 2 |
| 1 | *Staphylococcus albus* | *S. albus* | *S. aureus* | *Streptococcus viridans* | *S. albus* | *Strep. viridans* |
| 2 | | | | *S. albus* | *S. albus* | |
| 3 + | | *S. aureus* | | *S. albus* | *S. albus* | *S. albus* |
| 4 | *S. aureus* | | | | *S. aureus* | |
| 5 | | | | *S. albus* | *S. albus* | *S. albus* |
| 6 | | | | *S. albus* | *S. albus* | |
| 7 | *S. albus* | | | *S. albus* | | *S. albus* |
| 8 | | *S. albus* | | | *Strep. viridans* | *S. albus* |
| Total 8 | | | | | | |

+ Developed a wound infection with growth of *S. aureus* and *Proteus mirabilis*.
– No growth.

When gauze packs soaked in Hibitane spirit were added to the ring drapes in an attempt to protect the wound surfaces from bacterial contamination (Group C) it was found that all 18 wounds were sterile prior to drape removal (Table II). Once the drapes were removed, contamination of either the peritoneum or the wound surfaces occurred in five patients with wound infections following in three (16.7%).

TABLE II
*Bacteriological Examination of Wound and Drape Swabs in 18 Patients*

| Number of patients | Wound biopsies before drape removal | Drape swab | Peritoneal swab | Wound biopsies after drape removal | Wound infection |
|---|---|---|---|---|---|
| 13 | — | — | — | — | — |
| 1 | — | — | *Staphylococcus albus* | — | — |
| 1 | — | — | *Bacteroides fragilis* | — | — |
| 1 | — | — | *Escherichia coli* | — | + *E. coli* |
| 1 | — | — | *B. fragilis* | Diphtheroids | + *B. fragilis* |
| 1 | — | — | — | *B. fragilis* | + *B. fragilis* |
| Total 18 | | | | | |

+ Wound infection.
— No growth.

Wound infections occurred in 18% of the patients in the main trial. This figure is similar to that reported by Maxwell *et al.* (1969) but higher than that recorded by Alexander-Williams *et al.* (1972). The results of the present study clearly show that adhesive and ring wound drapes do not significantly reduce the wound infection rate in patients undergoing a wide variety of abdominal operations. No difference was found in any of the three operative groups, i.e. clean operations, procedures on the upper gastrointestinal tract and dirty operations on the colon and rectum. It is in this third group that one might expect the plastic ring drapes to offer some benefit by protecting the raw wound surfaces from contamination with gut organisms.

These findings are in agreement with those of Maxwell *et al.* (1969) and Alexander-Williams *et al.* (1972). Maxwell and his colleagues studied patients treated with either an adhesive plastic drape or both plastic adhesive drape and a Vi-Drape wound protector. Their study was not strictly speaking a randomized controlled trial as the third control group of patients in which standard linen towels alone were employed was added to the series later.

Neither type of plastic wound drape was found to have a significant influence on the wound infection rate.

Similarly Alexander-Williams and his colleagues (1972) failed to demonstrate any difference in the rate of wound infection between patients treated with a Vi-Drape wound protector and those without.

In marked contrast were the results obtained by Harrower (1968) and Ellis *et al.* (1969), who reported that impervious wound liners of the Vi-Drape type were capable of significantly reducing the wound infection rate following abdominal surgery.

A recent study of sepsis in patients undergoing cholecystectomy reported a remarkably low incidence of wound infection of 0.5% in a series of 200 patients (Corlette *et al.*, 1977). Wounds were protected by sewing a "sandwich" drape to the peritoneum with closely spaced interrupted sutures. The drape which completely isolated the wound consisted of a thin plastic sheet backed on both sides with cloth. Clearly a prospective controlled randomized study will be necessary to evaluate fully this method of wound protection.

A summary of the results of previous investigations of wound drapes along with the findings in the present series is included in Table III.

Only two studies (Harrower, 1968; Ellis *et al.*, 1969) were able to show significant advantages following the use of plastic drapes of the ring type. The report by Cole and Bernard (1967) of a zero incidence of wound infection following the use of a ring drape is difficult to interpret as no control group was studied.

TABLE III
*Summary of Investigations of Wound Drapes*

| Author | Incidence of Wound Infection (%) | | | |
|---|---|---|---|---|
| | Adhesive drape | Ring drape | Adhesive + ring drape | Control |
| Moreland *et al.*, 1962 | 9.7 | — | — | 8 |
| Cole and Bernard, 1967 | — | 0 | — | — |
| Harrower, 1968 | — | 2.4* | — | 15 |
| Ellis *et al.*, 1969 | — | 3* | — | 23 |
| Maxwell *et al.*, 1969 | 14.6 | — | 18.2 | 21.8 |
| Jackson *et al.*, 1971 | 14.2 | — | — | 11.6 |
| Alexander-Williams *et al.*, 1972 | — | 11.9 | — | 12 |
| Cruse and Foord, 1973 | 2.4 | — | — | 1.5 |
| Present Series | 16 | 17 | — | 21 |

* Significant difference between drape and control group.