

## SUTURELESS SKIN CLOSURE

## A CLINICAL TRIAL

BY

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Early and complete epithelization is an important factor in the satisfactory healing of wounds, and surgeons facilitate this by apposition and fixation of the skin edges. In the main, there are four methods of skin closure—bandaging, needle and suture, metal clips, and adhesive strips. Each method has its shortcomings, but there are certain advantages to a closure without stitches or clips. Adhesive strips in one form or another have been used intermittently for many centuries. The Ancient Egyptians (1600 B.C.) used linen strips smeared with glutinous substances; the early European surgeons used an oil and resin mixture as the adhesive (*emplastrum resinae*), and later zinc oxide was added (Golden, 1960). In 1793 John Hunter stressed the superiority of "dry sutures" over stitches in producing neither suppuration nor ulceration of the wounds (Palmer, 1837). However, strips have not been generally accepted because of their lack of firm skin adhesion and because the adhesives used have not been free of associated skin irritation or maceration.

In recent years the development of an entirely new form of surgical adhesive tape has renewed interest in the sutureless closure of wounds (Golden *et al.*, 1962). The tape ("steri-strip" skin closure) consists of a thin backing of rayon fibres laid in a random fashion to give a microporous structure. The adhesive is a chemically inert synthetic acrylic compound whose non-slip properties depend on pressure. Four-inch (10-cm.) strips of the tape are carried on a thin card and are provided sterilized in a peel-open polyethylene pack. Four sizes of tape width, ranging from  $\frac{1}{8}$  to  $\frac{1}{2}$  in. (0.3 to 1.3 cm.), are available.

This report is concerned with the results of a clinical trial of steri-strip skin-closure tape in out-patient wounds and lacerations, and in in-patient incisions.

**Methods of Application**

Before applying the strips it is essential to arrest any bleeding and to ensure that the skin is clean and dry. It was found that firm adhesion of the strips was facilitated if the skin surrounding the wound was cleaned with ether and then painted with compound tincture of benzoin. The width and length of the strips varied according to the site and length of the wound or incision and the tension required to effect closure. In general the  $\frac{1}{4}$ -in. (0.6-cm.) tape was used for small wounds and the  $\frac{1}{2}$ -in. (1.3-cm.) for larger incisions.

One side of the 3M strip was applied to one skin edge and pressed firmly into place. The wound edges were then apposed exactly with forceps or finger pressure and the free half of the strip was firmly applied to the other side of the wound. It was usual to place the first strip in the centre of the wound and further strips were applied at intervals until the wound was closed. The first strips sometimes needed replacing as the initial stress on them was eased by the later strips. Additional strips were occasionally laid in a criss-cross pattern or parallel to the wound to distribute the pull on the skin edges. Skin grafts were anchored by strips placed in a radial fashion passing from the graft to surrounding skin.

The wounds of the fingers and hand were covered with a small gauze dressing and "tubegauz"; no dressing was usually required on wounds of the forehead and face; wounds on other sites were covered with an "airstrip" dressing. The operation incisions were dressed with dry gauze. The out-patients, except for those who had digital reconstructions, were encouraged to stay at work and the in-patients were mobilized in the usual way according to the operation.

The wounds were inspected and the strips carefully removed after five to eight days, depending on their site, and the incisions after 8 to 14 days, depending on the type of operation.

**Out-patients**

During a period of six weeks 157 wounds received by 153 patients of varying ages were treated in the casualty department. The treatment, follow-up, and final assessment were carried out or supervised by one of us (N. G. R.). Antitetanus serum or a booster dose of tetanus toxoid was given to all patients. The majority of the wounds were of the fingers and hands (103); the other sites were forehead and face (32), forearm and elbow (16), and leg (6). They were classified into (1) incised, 102; (2) sliced or flap, 28; (3) lacerated or crushed, 22; and (4) digital amputations and skin loss, 5; and all penetrated the subcutaneous tissues.

Wounds of the scalp and eyebrows were excluded from the trial because the satisfactory application of 3M strips necessitates wide and close shaving of the hair around the wound. The only exception to this rule was in children.

The wound tray consisted of two small gallipots, containing "savlon" solution (0.5% cetrimide and 0.05% chlorhexidine) and compound tincture of benzoin; one pair of fine dissecting forceps; one pair of sharp-pointed scissors; a few gauze and wool swabs; and single 3M strips.

The wounds were gently washed with savlon and dried thoroughly; foreign debris and damaged or devitalized skin or fat were removed without discomfort to the patient. Local anaesthesia was not required except in the reconstruction of the digital amputations, where a local nerve block with 1% lignocaine was used.

The steri-strips were found to be easy to handle, and, provided the skin was kept dry and free of any ooze, firm adhesion and satisfactory approximation of the wound edges was obtained. They were comfortable for the patient, painless to remove, and left no gummy residue. No skin irritation was produced, but two or three of the early operation cases showed blistering due to undue tension on the skin. This was subsequently avoided by placing extra strips parallel to the incision, forming a ladder pattern. One patient developed a skin rash in the area painted with tincture of benzoin.

At the first inspection, usually after one week, the wounds were either found to be dry and healed by a sound scar (Fig. 1) or considered to be unsatisfactory if the edges were separated by moist granulation tissue, or if the strips

were loose and if infection was present. The results in these wounds are summarized in Table I. The majority of the wounds healed well and the ease of application and removal of the strips as compared with sutures was gratifying in all cases, and especially in children.

The reasons for the unsatisfactory state of the unhealed group were found to be due, in order of frequency, to:

1. *Faulty application* (13 wounds), allowing gaping of the wounds. This was mainly due to lack of experience with the method in the initial stage of the investigation. Wound edges

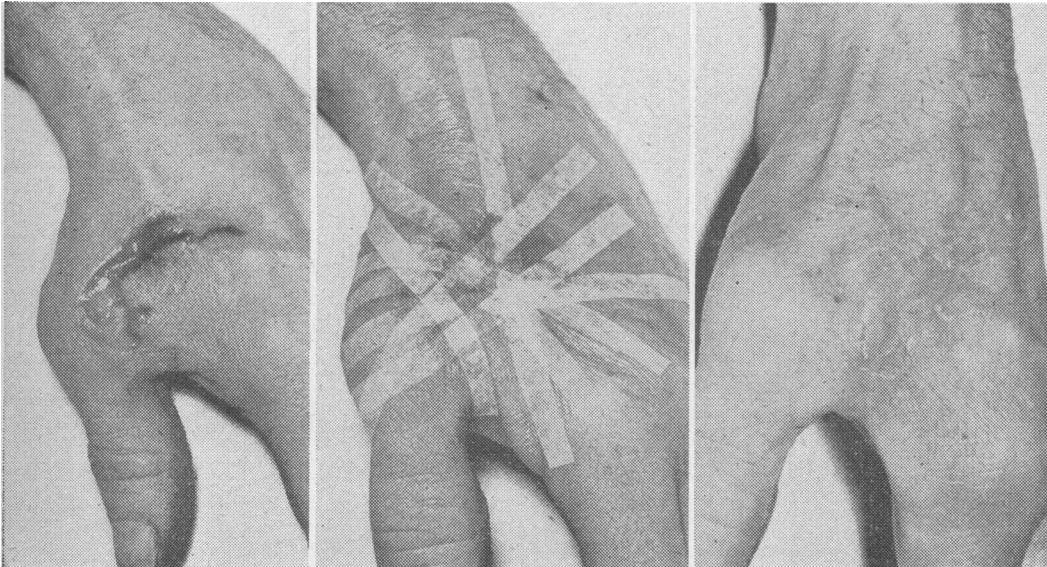


FIG. 1.—Laceration of hand treated by steri-strip closure without local anaesthesia. (a) Original laceration. (b) At time of closure. (c) Final result at 14 days.

TABLE I.—*Out-patient Wound Results at One Week*

	Incised	Sliced and Flap	Lacerated and Crushed	Amputations	Total
Healed ..	78	24	10	5	117
Unhealed ..	24	4	12	0	40
	102	28	22	5	157

were not apposed with sufficient tension; strips applied initially to the centre of the wound were not replaced when they became slack as others were applied on either side; and the pull of some strips was in the wrong direction. This particularly applied to flaps where a criss-cross pattern was usually necessary (Fig. 1 b). All these wounds were clean and either required the careful reapplication of 3M strips or cover with an airstrip dressing. They were all dry and healed after a further week.

2. *Dampness of the dressing* (11 hand wounds) from repeated external wetting or oozing from the wound resulted in loss of adhesion with loosening of the strips, which came off easily with the first dressing. This allowed gaping of the wound, and the continued contact with the wet dressing caused skin maceration. Some of these damp strips were torn across by movement of the part. The wounds were covered by further 3M strips or an airstrip dressing and the patient was advised to avoid wetting the dressing. All healed satisfactorily after another week.

3. *Laceration and crushing* (8 wounds) caused protrusion and oedema of the subcutaneous tissues and irregular wound edges which were not always adequately apposed by the 3M strips. These wounds, however, all dried up and healed well without further loss of skin in two to three weeks. The subsequent appearance and function were satisfactory.

4. *Unsuitable site* (5 wounds), where movements caused loosening of the strips and separation of the edges. Transverse cuts in the flexion creases of the fingers and over the

knuckles, and especially around the base of the finger, were unsuitable. Even with careful criss-cross application these cuts took longer to heal than with sutures when finger movements were allowed to continue. Vertical cuts on the dorsal surface of the finger webs were not well apposed by strips, and the eyelid was too loose a structure to hold strips firmly. At all these sites healing was delayed by one to two weeks.

5. *Infection* (3 wounds) was only severe in one—a small boy who received an incised wound of the forehead. He developed a subcutaneous staphylococcal infection on the third day which discharged well through the upper end of the cut and responded to pheneticillin. There was little inflammatory reaction in the skin around, healing was not delayed, and the final cosmetic result was satisfactory. The infection in the other wounds was mild and settled rapidly.

It must be stressed that none of these unsatisfactory early results were in any way serious, and sound healing occurred within two weeks. These complications became less frequent in the latter part of the trial as experience in the use of the 3M strips was gained.

In only four patients was the application of strips abandoned because of unsatisfactory apposition and haemostasis. All these wounds were situated on the extensor surface of the metacarpophalangeal joints and were closed by stitches.

#### In-patients

A total of 124 incisions in 112 patients were closed with 3M steri-strip. The operations embraced a wide field of general surgery and on a regional grouping included 58 laparotomies, 54 limb procedures, and 12 operations on the neck or chest wall. The laparotomy group embraced most standard incisions, including full-length paramedian incisions for resection of aortic aneurysm. Many of the limb incisions were employed for peripheral vascular surgery and were made through skin damaged by ischaemia or venous disease. The deeper layers of the incisions were closed in the usual way and special care was taken to close the subcutaneous tissue with fine catgut. This was particularly necessary in laparotomy wounds in obese patients, and more than one layer of sutures in the subcutaneous tissues was necessary in these circumstances. Some of the laparotomy patients developed significant abdominal distension in the immediate post-operative period, but despite the lack of elasticity of the strips their adhesion remained firm and healing proceeded uneventfully. A number of incisions were closed half with sutures and half with strips, so that a comparison could be made; and, similarly, where bilateral symmetrical incisions were used one incision was closed by sutures and the other by strips.

Most of the incisions healed in a satisfactory manner (Table II), and the absence of the inflammatory reaction usually associated with sutures was particularly noticeable. This is best demonstrated in wounds closed with both strips

and sutures (Fig. 2). Incisions made through ischaemic skin or skin devitalized by venous disease always healed more satisfactorily in the strip section than in the sutured area (Fig. 3). In certain distal amputations (transmetatarsal

TABLE II.—In-patient Wound Results at One Week

	Laparotomy	Limb	Other
Healed . . . . .	57	48	12
Unhealed . . . . .	1	6	0
	58	54	12

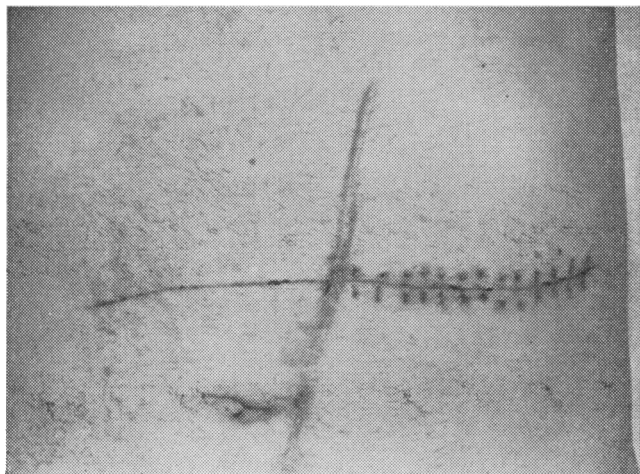


FIG. 2.—Transverse abdominal incision; right half closed by steri-strips, left half by sutures. Note absence of inflammatory reaction in the sutureless portion.

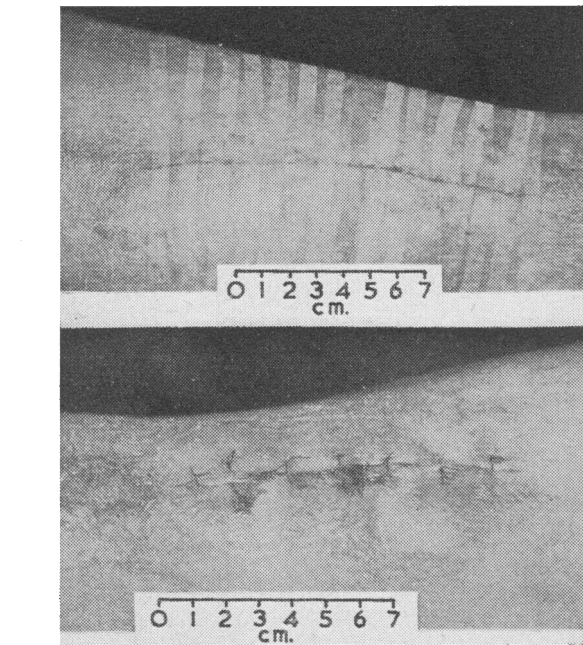


FIG. 3.—Simultaneous incisions in opposite legs in a patient with post-phlebotic skin damage. The steri-strip incision has healed by first intention, while necrosis has occurred on the sutured side.

and digital), done for ischaemia, the strips were left in place for two to three weeks (Fig. 4). This continued support was beneficial in view of the slow healing in these limbs and did not involve the strangulation of tissue or risk of infection that follows delayed removal of sutures. In no case did failure to obtain primary healing derive from unsatisfactory apposition of wound edges. In all the failures

delayed healing was due to infection, and most of the infections occurred in limb incisions where ischaemic infected gangrene or venous ulcers had been present. When infection occurred the exudate from the wound loosened the strips in the immediate vicinity and satisfactory drainage occurred spontaneously.

Certain incisions do not lend themselves to strip closure, and the method was not used in these unsuitable circumstances. Adequate apposition could not be securely obtained in inguinal incisions in the very obese, and in some mastectomy wounds, where the margins of the defect had unequal length, adjustment and accurate coaptation was more easily obtained with sutures.

The cosmetic appearance of the matured scar was generally good and was enhanced by the absence of cross-hatching and punctate scars which follow suture closure. It was noticeable, however, that in incisions which transgressed lines of skin tension (vertical abdominal scars) the final scar was sometimes broader than that obtained with sutures. This criticism did not apply to incisions lying in the line of natural skin folds.



FIG. 4.—Amputation of gangrenous hallux done concurrently with arterial grafting. Flaps opposed by steri-strip tape.

**Discussion**

In a study of wound healing Gillman *et al.* (1955-6) showed that downward migration of epithelium occurs at a very early stage and precedes the connective-tissue reaction in the deeper parts of the wound. These workers also demonstrated that epithelial downgrowth and connective-tissue activity occurred at needle-puncture sites and along the tracks of sutures. This reaction to suture material contributes nothing of value to the healing process and constitutes a material addition to the final scar. Dunphy and Jackson (1962), following an experimental study of wound-healing, concluded that eversion of the wound edge was unnecessary and that simple apposition was sufficient to produce a satisfactory scar. It is also well established that the presence of sutures considerably lowers local resistance to infection (Elek and Conen, 1957; Taylor *et al.*, 1961-2). In addition, tension produced by the ligature effect of a tied suture may be harmful, especially in skin already damaged by ischaemia or other pathological processes. There is, therefore, good theoretical support for methods of skin closure which avoid the use of sutures. In this trial the absence of inflammatory reaction around the taped incisions was particularly striking. The method has especial application when incisions transgress unhealthy skin, and, in those instances in which bilateral incisions could be compared, healing by first intention was more often achieved in the sutureless wounds. From a cosmetic point of view the theoretical advantage of sutureless closure was lessened in certain instances by a broadening of the final scar. This occurred particularly in incisions cutting across lines of natural skin tension.

In the out-patient series it was found practicable to manage most minor wounds and lacerations by sutureless closure without the use of local anaesthesia. Gentle cleaning of the wound and excision of small areas of devitalized tissue were usually possible without causing discomfort to the patient. Because of the ease of application of the strips and lack of necessity for local anaesthesia, this method has many advantages for small wounds of the kind usually treated in general practice or in an out-patient department. Indeed, the very simplicity of the technique engenders a risk that wounds in which full exploration is required may be closed *ab initio*. Careful assessment of traumatic lesions is therefore necessary before proceeding to sutureless closure without anaesthesia.

The combined results of this clinical trial have demonstrated that steri-strip tape is a reliable and practical means of skin closure for the majority of wounds and incisions. We would particularly advocate the use of tape closure in the following circumstances: (1) where incisions transgress skin devitalized by ischaemic or venous disease, or whenever there is a special risk of infection; (2) incisions and wounds in children; (3) suitable traumatic wounds; and (4) fixation of small skin grafts.

## CLOSURE OF SKIN WOUNDS WITH ADHESIVE TAPE PRELIMINARY REPORT BASED ON USE OF TAPE IN 100 SURGICAL CASES

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The idea of closing skin wounds with adhesive tape instead of sutures or metal clips is not new. The disadvantages of using sutures and the advantages of using tape for the closure of wounds have been critically assessed by Gillman *et al.* (1955) and Gillman (1958). The lack of suitable materials, however, has prevented it from being exploited except on a very limited scale. Recently I have had an opportunity of testing two forms of a new type of microporous surgical tape,\* which is permeable to water vapour and, it is claimed, does not cause skin reactions even in patients who are hypersensitive to conventional adhesives. Apart from the roll form, supplies of the tape in a sterile pack† are available, the latter being designed for the tape closure of wounds as an alternative to skin sutures. Sterilization is carried out by ethylene oxide gas.

**Method of Application.**—The deep layers of the wound are closed in the usual way: subcutaneous sutures were inserted in this series only when a change in direction of the wound occurred or when skin flexures were crossed. The skin around the wound is thoroughly cleaned and dried, preferably with ether. Pieces of tape are applied at right angles to the wound, one side being applied first and firmly pressed down. The edges of the wound are then drawn together and the tapes firmly pressed down on the other side. For further security the tapes may be criss-crossed and reinforced at the edges. The taped wound is dressed with dry gauze and secured with an adhesive tape, or it can be left exposed. The manufacturers‡ supply a surgical tape in roll form of the same non-irritating material as the wound-closure strips, which can be used instead of existing plasters. The microporous surgical tape is ideal

### Summary

A clinical trial of a new form of adhesive tape was carried out to assess its use in skin closure.

The results obtained in 157 wounds and lacerations in out-patients and 124 operation incisions in in-patients are given. Satisfactory primary healing was obtained in most of the patients, and the reasons for any delay in healing are analysed. The advantages of the tape are discussed and certain indications are given for its use.

We wish to thank Sister P. E. M. Cocking for her help in the out-patient trial and the photographic department of St. Bartholomew's Hospital for the illustrations. The steri-strips were supplied by the Minnesota Mining & Manufacturing Co. Ltd. through Mr. W. D. C. Padfield.

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for this purpose as it does not adhere to itself. If wound inspection is required the outer dressings must be removed in such a way as not to disturb the tapes.

### Results

The present report is based on 100 cases in which tape was used for the primary or secondary closure of skin wounds after a variety of surgical procedures or the repair of facial lacerations (see Table). In general it was found that the tape was easy to apply, but the importance of applying it to dry clean skin is stressed. In patients with

#### Types of Operation

Lumbar sympathectomy ..	14	Hemicolectomy .. ..	1
Appendicectomy .. ..	29	Retropubic prostatectomy ..	3
Herniorrhaphy (inguinal or femoral) ..	12	Reduction of ectopic testes ..	2
Laparotomy for intestinal obstruction .. ..	6	Biopsy of breast tissue .. ..	1
Partial gastrectomy .. ..	3	Nephrectomy .. ..	2
Gastroenterostomy .. ..	1	Excision of submandibular gland .. ..	1
Closure of perforated peptic ulcer ..	5	Facial lacerations .. ..	2
Amputations .. ..	4	Secondary repair of wounds ..	14

a greasy skin it was found that the adhesive qualities of the tape were enhanced by painting the skin with compound tincture of benzoin. Some difficulty was experienced when the tapes crossed skin flexures such as those in the groin or neck, where subcutaneous sutures were found inadequate to hold the skin edges together. In these cases Michel clips were applied as a temporary means of opposing skin edges; the tapes were placed in position between the clips, which were then removed immediately taping was completed.

Of the 100 cases presented the tapes gave satisfactory results in 94. In comparison with a sutured wound they were easier and quicker to apply, and they produced a fine linear scar with no suture marks (see Fig.). There was a

\*3M "Micropore" surgical tape No. 1530.

†The strips are identified as 3M brand "steri-strip" skin closures.

‡Minnesota Mining and Manufacturing Co. Ltd., 3M House, Wigmore Street, London W.1.