

SURGICAL AIDS

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These are referred to a wide range of materials used for dressing of wounds or injured or diseased tissues (Surgical dressings); some are used to hold wound edges closely during healing (sutures and ligatures). All these materials are collectively called surgical aids.

SURGICAL DRESSINGS

Definition Surgical dressing is a term applied to a wide range of materials used for the dressing of wounds or injured or diseased tissues.

Dressings may serve to :

i) Provide an environment for moist wound healing.

[N.B. Drying of the wound is a major factor in retarding wound healing and increasing scarring.

Dressings which prevent drying (or desiccation) provide an optimal environment for autolysis, cell migration, granulation and re-epithelialization.]

ii) Prevent maceration by permitting evaporation or absorption.

[N.B. In highly exudative wounds, excessive moisture and autolytic enzymes will damage repairing tissue, and will provide a perfect culture medium for microbes.]

iii) Promote haemostasis (i.e. stops bleeding)

iv) Protect the wound from further damage [e.g. mechanical damage, microbial invasion, dehydration, maceration, chemical damage, alteration in pH.]

v) Reduce heat loss.

vi) Control microbial growth by incorporation of antimicrobial drugs.

vii) Promote healing.

viii) Provide compression, promoting haemostasis and reducing oedema.

ix) Reduce pain, increase patient comfort and improve functional use for wound site.

x) Reduce odour.

xi) Improve appearance of the wound site.

xii) Reduce overall costs associated with wound treatment.

Features of an ideal dressing

- i) The dressing should be porous to water vapour; otherwise sweat from the surrounding skin, water evaporated from the epidermis, and tissue fluid exuded from the wound will accumulate and delay the healing process.
- ii) It must be capable of absorbing excess secretions.
- iii) Free from substances that cause tissue reactions , allergy or a hypersensitivity response.
[N.B. Fluorescent agents (optical whiteners), used to improve the appearance of bleached materials, delay healing.]
- iv) It must be impervious to micro-organisms.
- v) It must be impervious to fluid from outside.
- vi) Capable of following joint contours during movement.
- vii) It should have tensile strength to withstand stretching during movement.
- viii) It must be non-inflammable.
- ix) It must be sterilizable by conventional means.
- x) Capable of preventing excessive movement of wound.
- xi) Inexpensive.

It is obvious that not a single dressing has all of the above qualities.

Classification of surgical dressings:

Functionally surgical dressings can be divided into primary, and secondary dressing.

A **primary** dressing directly come in contact with the wound. It may provide absorptive capacity and may prevent desiccation, infection and adhesion of the secondary dressing to the wound.

A **secondary** dressing is placed over the primary dressing for further protection, absorptive capacity, compression or occlusion. Although some dressings are solely primary or secondary in nature, others have the characteristics of both. The following classification can be made:

- i) primary wound dressings
- ii) primary/secondary wound dressings
- iii) secondary dressings
 - (a) Absorbents
 - (b) Bandages
 - (c) Adhesive tapes
- iv) Protectives

PRIMARY WOUND DRESSINGS

Plain gauze

This is a soft cotton cloth of plain weave, open texture and filmy appearance.

Use: Because the cotton is in the form of spun threads and not loose fibres (contrast cotton wool) gauze can be applied directly to the wounds. It absorbs water readily but unless many folds thickness are used, it is not bulky enough to cope with the exudate or give adequate protection to a large wound. Hence, it is usually covered with more absorptive and protective dressing.

Wicks of gauze are used, after surgery, for draining exudate from large wounds.

Impregnate gauze

Cotton, rayon or cellulose acetate gauze has been impregnate with a variety of substances such as petroleum or paraffin, vaseline or petrolatum emulsion.

They are used to reduce its adherence to wounds.

Oiled silk: This is a silk fabric of plain weave, evenly water proof by treatment with drying oils. Oiled silk is used

- i) to cover wet dressings, such as poultices and compress to keep them moist.
- ii) to protect clothing from dressing.

Paraffin gauze dressing: This is a sterile dressing consisting of pieces of cotton, rayon or cotton and rayon gauze impregnated with yellow soft paraffin or it for use in warm countries, soft and hard paraffin.

Paraffin gauze dressings are used in skin grafting and for paraffin prevents adherence to the tissues and the open nature of the gauze allows air to reach the wound and exudate to drain away into secondary absorbent dressing.

Film dressing: are films of polyurethane with acrylic or polyether adhesives.

- i) In lightly exuding wounds they permit enough evaporation to promote moist wound healing and prevent maceration.
- ii) Film dressings exclude bacteria from wounds and permit bathing and observation of the wound.
- iii) They will adhere well to intact skin and have a low adherence for wound tissues.

PRIMARY / SECONDARY WOUND DRESSINGS

Composite dressings: consists of lightly absorbent rayon or cotton pads sandwiched between porous polyethylene films.

Hydrogels are cross-linked polymer such as poly-vinyl-pyrrolidone (PVP), cross-linked polyethylene oxide gel or polyacrylamide in which the wound exudate may be trapped.

Uses: Hydrogels are non adherent dressings, which through semipermeable film allow a high rate of evaporation (and cooling) without compromising wound hydration. This makes them useful in burn treatment.

Hydrogels are very useful in hairy areas where entrapment of hair into the dressing would not be traumatic.

Calcium alginate dressings:

Alginic acid is naturally occurring polysaccharide derived from a type of seaweed. The calcium salt is a fibrous non-woven dressings which are highly absorbent.

Use: They are used on moderate to highly exuding wounds.

They may be held in place with gauze tape or a film dressing.

SECONDARY WOUND DRESSINGS

ABSORBENTS

Surgical cotton

The raw cotton fibre, mechanically cleaned of dirt and processed to remove the natural waxes on the cotton fibres. The fibres are defatted with alkali, bleached, washed and dried. It is available as rolls or small balls.

Use:

- i) It absorbs water readily hence used for absorbing wound exudates. However, as its fibres are loose (i.e. not in the form of a thread, they irritate and adhere to raw tissues, hence cotton should be separated from wounds by a woven fabric dressing.

- ii) it can be used for cleaning, swabbing and medicating wounds and for applying bactericidal solutions to the skin before surgery.

Surgical gauzes:

The function of surgical gauze is to provide an absorbent material of sufficient tensile strength for surgical dressings.

Processing: Raw cotton fibre is cleaned and spun or twisted into thread, and the threads are woven into an open-mesh cloth. It is then bleached white and defatted to increase the absorbency.

Use: Various forms of pads, compressed and dressings are made from surgical gauze, alone or with absorbent cotton, tissue paper and other materials.

Other forms of secondary dressings are:

- i) sanitary napkins
- ii) eyepads
- iii) disposable under pads
- iv) cotton-tipped appliances etc.

BANDAGES

The function of bandages is to hold dressings in place by providing pressure or support. They may be inelastic, elastic or become rigid after shaping for immobilization.

common Gauze Roller Bandages: Each bandage is in one continuous piece, tightly rolled and substantially free from loose threads. It may be of various widths and lengths for various purposes.

Muslin Bandage Rolls: This bleached cotton cloth of plain but closely weaved. They are very strong and are used wherever gauze bandages do not provide sufficient strength or support. They are frequently used to hold splints or bulky compression dressing in place.

Elastic bandages:

(1) **Cotton and Rubber Elastic Bandages:** This bandages has a cotton weft but the warp contains rubber threads.

(2) **Crepe bandage** is elastic but contains no rubber. The warp threads are of cotton and wool and the weft threads are cotton. The wool content is not less than 33(1/3)%

The arrangement of the warp threads:

1 two-fold cotton thread with an S twist

2 wool threads

1 x two-fold cotton thread with Z twist

2 wool threads

The opposite twists of the alternate cotton threads gives the bandage its considerable elasticity.

Use: Crepe bandage conforms well to body contours allowing limited movement and stretching if swelling takes place. Hence it is very useful –

- i) for giving light support to sprains and strains
- ii) for correctional purposes and
- iii) as a compression bandage.

(3) **Cotton Conforming Bandage**

If cotton gauze is mercerized under very carefully controlled conditions the fibres become bent (crimped) and this imparts elasticity to both warp and weft. The sides of the fabric are folded into the centre to avoid rough edges and produce a thicker, more absorbent layer.

Uses: Cotton conforming bandages are used to protect and secure dressings.

There is no need to reverse turn it during application. The overlapping parts do not slip because the crimped fibres tend to interlock.

ADHESIVE TAPES

When some adhesives are spread over a backing membrane it is called an adhesive tape.

This tapes are used

- (i) to secure dressings and appliances firmly in place.
- (ii) for support and compression e.g. for fractured ribs and clavicles, sprains and leg ulcers etc.

The adhesive tapes differ with the type of backing membrane (e.g. pain cloth, elastic cloth, plastic film).

Depending on the adhesive the tapes may be subdivided into two categories:

- (i) rubber based adhesive and

(ii) acrylate adhesive.

Rubber based adhesive tapes:

These are cloth-backed rubber adhesives. these are used principally where heavy support and a high level of adhesion are required.

Acrylate adhesive tapes

In this case non-woven or fabric backing are spread with acrylate adhesives.

Acrylate adhesives are hypoallergenic i.e. they do not produce any allergic reaction.

Rubber adhesives generally contains a large number of components of which few may cause the allergy.

Because acrylate adhesives are basically a unipolymeric system, they eliminate the possibility of allergy.

STERILIZATION OF SURGICAL DRESSINGS

Surgical dressings are packed in drums made of steel and sterilized by moist heat sterilization; the outline of the process is as follows:

By horizontal automatically controlled autoclave:

- i) Suitably packed dressings are correctly loaded into the chamber (autoclave).
- ii) The door is closed and steam is admitted to the jacket.
- iii) Air is partially or almost completely removed by vacuum.
- iv) Dry saturated steam is admitted and if, necessary may be used to displace the rest of the air.
- v) Heating up and exposure are carried out; air (drained from the dressings) and condensate are automatically discharged meanwhile. Either 115⁰C is maintained for 30 mins or 121⁰C is maintained for 15 mins.
- vi) After the stipulated period the supply steam is cutoff and the chamber is vented.
- vii) The dressings are dried either by drawing a high vacuum or by using a partial vacuum to suck warm sterile air through them.
- viii) When high vacuum drying has been used the vacuum is broken by admitting sterile air.

STERILITY TEST OF SURGICAL DRESSINGS

Cotton wool, gauze, lint and adhesive plasters are examples of dressings that may require sterile. Before sterilization cotton wool may be heavily contaminated with microorganisms. As an example, gauze may carry about 15 organisms/ cm² . Since surgical dressings are used in direct or close contact with wounds or, in the case gauze, within the operation field during surgery the method of confirming sterility must be reliable.

Sampling:

Samples are of about 1 g or 10 cm² are taken from woven or non-woven fabric respectively. These are chosen from different places, including regions, such as the centre (contamination is minimum) and the outside (where the probability of contamination is maximum). A test and if required (and possible) two more repeat samples are taken.

Controls:

To check the tester's technique and the bacteriological condition of the atmosphere, a control is performed at the same time as the test. Items that have been recently sterilized by a process known to ensure sterility are used for this purpose. They should be equal in number to the test items and preferably identical in structure. No growth should occur in any container.

Elimination of inhibitory action:

Some surgical dressings are impregnated with antimicrobial agents which may interfere with the growth of microorganisms in the culture medium. The action of antimicrobial agents in medicated dressings is eliminated either by including a suitable inactivator in the culture medium or preferably by membrane filtration.

Procedure:

1. The test is performed in an aseptic room or a screen provided with laminar flow of sterile air.
2. The dressings are generally wrapped in double wrapping. The area through which the outer wrapper is to be opened is first painted by Weak Iodine Solution B.P. and left for 5 mins. The outer wrapper is cut along the painted sterile line with a sharp scalpel or blade. The dressing is pulled out off the outer wrapping. The dressing is also drawn out of the inner wrap by a similar method.
3. If the dressing is a bigger one then 1 g or 10cm² samples are cut by a pair of sharp scissors from different areas of the fabric.
4. Each portion of the dressing is inoculated into separate wide mouthed container containing 50, 100 or 150 ml of a suitable culture medium (e.g. fluid thioglycolate medium U.S.P.). It is then incubated at $32 \pm 2^{\circ}\text{C}$ for at least 10 days.
5. *Interpretation:*
 - i) If there is no growth in any of the containers the batch passes.
 - ii) If growth occurs in only one container the test is repeated and, if the same result is obtained again, a second repeat is allowed.
 - iii) The product fails if there is growth in all three tests of the same organism is found in two.

SUTURES AND LIGATURES

- A surgical suture is a strand or fiber used to hold wound edges in application during healing.
- A ligature is a thread or string without a needle which is used to tie blood vessels and other tissues together.

CLASSIFICATION OF SUTURES

- (i) Absorbable and (ii) Non-absorbable

ABSORBABLE SUTURES

Surgical gut / Catgut

Catgut is prepared from the intestine of the sheep.

N.B. The name is said to be derived from the word “kit-gut” (a ‘kit’ being a small violin used in olden times)

- Raw material: When sheep are slaughtered the intestines are roughly washed and placed in cold brine for transport.
- Washing: The intestines are washed thoroughly with water.
- Splitting: The intestinal tube is fitted over the end of a flat curved peg and then splitted longitudinally with a knife into “smooth” ribbons.
- Mechanical processing: Mechanical processing remove the innermost mucosa and the outer muscularis and serosal layers, essentially leaving only the submucosa. This appears as a thin, strong network consisting chiefly of collagen.
- Chemical processing: At this stage the ribbons may be tanned or hardened by soaking in solution of chromic salts. This causes delay in the absorption depending on the strength of solutions used. Such products formerly were designed as 10, 20, or 40 days catgut, on the assumption that these sutures would remain for such periods in normal tissues. The variations in catgut depends on the variations in patients and on the sites of implantation. Two varieties of catgut, as distinguished by their resistance to absorptive action by tissue enzymes are described in the USP as Type - plain or untreated and
Type C - medium treatment.

In other terms they may be called as ‘plain’, ‘chromic’ or ‘extra chromic’.

- Spinning: The ribbons are next tied at the ends in groups of two, three or more, depending on the gauge of thread to be prepared, pulled to an even tension and spun. Hardening and chromicising

may be done at this stage, but here it produces a case-hardened effect, the center of the string being unaffected by the chromic solution.

(viii) **Drying:** This is done in an atmosphere conditioned with regard to temperature and humidity, the strings being kept under a suitable tension.

(ix) **Finishing:** The dried strings are 'polished' by mechanical means. This is really a smoothing process, in which the strings are rubbed against an abrasive surface to produce a smooth, uniform string of circular section.

(x) **Sterilization:** The sheep intestine is normally infected with bacteria and is likely to contain pathogenic organisms such as the sporing anaerobic bacteria responsible for tetanus and gas gangrene.

The gut may be sterilized by chemicals, heat or ionizing radiations.

Chemical process: In this process the guts are sterilized by immersing them in iodine solution for a prolonged period. The disadvantage with this method is the variable increase in absorption time in the body.

The heat process:

Tubing: Suitable lengths of gut are coiled on a heat-resistant fibre card and placed in glass tubes along with a label of heat-resisting material, printed with heat-resistant ink.

Drying: The tubes are placed in baskets and dried in a drying oven in which the temperature is raised slowly to avoid damaging the gut. When thoroughly dried it is ready for the sterilization process which may be done in one of two ways.

1. The baskets of tubes are placed in an autoclave containing an anhydrous fluid such as toluene or xylol. A temperature of 160° C is maintained for several hours. [N.B. The catgut consists of collagen, which is converted into gelatin if heated in presence of moisture hence the anhydrous solvents are used.]
2. Alternatively, the heating may be done in a non-pressure vessel using an anhydrous liquid of high boiling point so that a temperature of 160° C can be readily maintained.

The tubes are then filled with sterile tubing fluid and sealed by fusion of the glass. This part of the process must be done under stringent aseptic conditions.

Ionizing radiation process: In this process the prepared gut is packed in aluminum foil envelopes containing 90 percent isopropyl alcohol as a preservative. The packets are then passed through a gamma irradiation area on a conveyor system. Thus catgut is sterilised when sealed in final container

and the process is a rapid one. Each suture receives a minimum dose of 2.5 megarads (unit of radiation).

BOILABLE AND NON-BOILABLE CATGUT

If the tubing fluid is anhydrous the tubes may be boiled before opening it for use; this type of catgut is called "boilable catgut".

If the tubing fluid contains water the tubes of the catguts are labeled 'Non-boilable'. This is a warning to avoid the use of heat in sterilizing the outside of the tube prior to opening it for use.

Non-boilable guts are more popular because the water in the tube keeps it pliable and immediately ready for use. The non-boilable tubes are filled with alcohol containing a small quantity of water.

SYNTHETIC ABSORBABLE SUTURES

Polymers derived from

- i) condensing the cyclic derivative of glycolic acid (glycolide),
- ii) mixtures of glycolide and lactide (derived by cyclizing lactic acid)
- iii) dioxanone and glycolide with tetramethylene carbonate

have shown to possess high tensile strength and absorbability.

The first two polyesters mentioned are melt-extruded into multifilament yarns which then are braided into various sizes of sutures.

The second two polyesters are provided as pliable monofilaments.

Sterilization: They are packaged without fluid and sterilized with ethylene oxide to avoid degradation.

Synthetic absorbable sutures do not undergo the enzymatically mediated absorption process that is well-known for catgut. Rather, the suture is broken down completely by simple hydrolysis as it resides in the tissue. Tissue reaction is minimum since scavenger leukocytes are not involved significantly in the absorption process.

Standards:

The following tests are given in the *British Pharmaceutical Codex*.

Sterility tests: The tests for sterility are intended for detecting the presence of viable forms of microorganisms on the surgical suture materials.

Method 1: The suture materials are washed with a sterile fluid, the fluid is then passed through a filter membrane (for filtering bacteria), the filter membrane is then incubated in sterile medium and observed

for minimum of 7 day. If any viable form of microorganisms were present in the suture material they will grow.

Method-II: The suture materials are incubated in culture medium for not less than 14 days. If microorganisms are present they will render the medium turbid.

Gauge: This is measured by means of a dial reading micrometer at several points along the strand.

Tensile strength: This is done by means of a machine in which the load necessary to rupture the gut is measured, the tests being performed on 'straight' and 'knotted' samples.

NON-ABSORBABLE SUTURES

This group of sutures are relatively resistant to attack by normal tissue fluids.

When non-absorbable sutures are used for skin closure, they usually are removed after the wound has healed to the point where suture support is no longer necessary.

Generally silk, linen, cotton, metallic wire, nylon and dacron are given in USP.

Silk:

Degummed commercial silk fibres consists chiefly of the protein fibroin as extruded by the silk-worm. Many such fibers are twisted into a single strand of various diameters as specified in USP, and sold in the natural colour or after dyeing.

Silk sutures are handled easily, and tolerated well by body tissue, although they may cause significant tissue reaction. The microorganisms can remain concealed in the interstices of silk strand and may protect them from antimicrobial agents. So chronic wound may not heal unless the suture is removed.

Silk occasionally migrates from the site of implantation and comes to the surface.

In certain sites the knots may produce irritation and may remain encapsulated in the tissue.

Dermal Silk

These sutures consists of natural twisted silk encased in an insoluble coating of tanned gelatin of other protein. This coating must withstand autoclaving without stripping.

Its purpose is to prevent the in-growth of tissue cells which would interfere with its removal after use as a skin or dermal suture.

Cotton and Linen

Sutures derived from cellulose, they are twisted from fiber staple, have moderately high tensile strength and are stable to heat sterilization.

Synthetic non-absorbable sutures:

Nylon is a polyamide obtained from the condensation of adipic acid and hexamethylenediamine or from the polymerization of caprolactum.

It is strong, water-resistant and can be used for all suturing and ligating.

Polyester fibres are multifilament synthetic fibres. They are prepared by melt-extruding polyethylene terephthalate into fine filaments which are then braided into various sizes.

The polyester sutures do not lose strength in contact with water or body fluids, for this reason they are used for permanent reinforcement as, for example, in installation of artificial heart valves.

They have the advantage of excellent knot holding characteristics and are available in the natural colour or dyed to enhance visibility in the surgical field.

Polyoelfin fibres : Examples are polyethylene and polypropylene.

Polypropylene sutures compared to monofilament nylon, tie more secure knots and have a very low order of tissue reactivity. Because of the smoothness, they slip through tissue in-growth, they may be removed easily when necessary. They are widely used in cardiovascular and other surgical specialties.

Metallic sutures:

Silver: Among the older materials which are still used to some extent are silver wire, foil and other forms. Silver though has some antiseptic action but in some tissues it produce irritation.

Stainless steel is a ferrous alloy is resistant to chemical attack has been used widely in the form of wire sutures, fixation plates, screws and other items.

Stainless steel sutures are available both as twisted and monofilament strands and presents the strongest available material. However, they are relatively difficult to use and are employed most commonly in areas where great strength is required, such as in the repair of the sternum after chest surgery.

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