Operative Surgery and Management

Edited by
G. Keen

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Preface

The increasing elaboration of surgical care, with the emphasis on critical and objective assessment of this care, has established a clear need for an up-to-date textbook of operative surgery. The days when an individual or a handful of contributors could write such a book are gone, and I have been fortunate to secure the co-operation of over fifty surgeons, each an authority, or having particular interest in his subject.

The complete field of operative surgery, with the exception of ear, nose and throat and ophthalmic surgery, is covered. Bearing in mind the long and comprehensive training required in surgery, I have, in addition to the traditional topics, included sections on neurological, reconstructive, thoracic, neonatal and cardiovascular surgery. Each author has presented the main features of his subject, emphasizing the indications for and the techniques of important surgical operations. A full discussion of postoperative care and of the management of complications is included.

The book is intended for trainees and residents in general surgery who are preparing for higher professional qualifications and, having regard to those who will find the book useful, each contributor has avoided highly controversial methods of treatment. It is hoped that it will also serve as a useful handbook for the practising surgeon.

The text has been illustrated by several medical artists, but I wish to express my particular gratitude to Mrs Clare Burford, Mr Frank Price and Mr Peter Cox, who undertook the greater part of this work.

I would like to thank the managing and editorial staff of John Wright & Sons for their continued encouragement and support in the preparation of this textbook.

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Contents

Introductory

Chapter one

Suture Material and the Healing of Surgical Wounds

A.B. CASSIE

As surgery evolved through generations of discovery, experience and evaluation to become a science with the attributes of precision and predictability, so the healed and uncomplicated surgical wound came to be regarded as the only acceptable outcome of an operation.

Nevertheless, wound complications such as infection, disruption and chronic discharging sinus are by no means uncommon. Wound behaviour, both surgical and traumatic, is greatly influenced by suture material and its use. Although trusted methods and materials are not readily abandoned, some may be based on tradition, inheritance and faith, failing to acknowledge newer understanding of the healing process and the performance of the vast choice of suture materials now available.

Consideration must therefore be given to some of the factors which influence wound healing and consequently affect the conduct of the surgical exercise in relation to suture material.

WOUND HEALING

Wound strength is dependent on the approximation and healing of the fascial layers (or in gut the collagen supporting layer, the submucosa). No other layer exhibits equivalent strength. Although preliminary fibrinous adhesion commonly occurs, within 24 hours, between the serosal surface of bowel or in the skin, to be followed by epithelization, very little wound strength is achieved until the formal healing process is begun.

Three phases of healing are commonly recognized.

The Lag Phase extends from the 1st to the 4th day. An inflammatory response accompanied by haemostasis and the assembly of the components for collagen synthesis occupies this period. At this stage, wound strength is entirely extrinsic and reliant on sutures.

The Proliferative Phase from the 5th day to the 20th reflects the laying down of collagen lattice and a rapid increase of intrinsic wound strength becomes evident. Approximately 30 per cent of the pre-injury strength is regained in this period.

The Remodelling Phase occupies the period from day 21 to 1 year and reflects the constant absorption and replacement of collagen more appropriately orientated to the lines of stress. Finally fibroblast regression occurs and the wound appears stable. Seventy per cent of the original fascial strength is regained by 1 year. Prolonged extrinsic support from suture material may be advantageous.

The outcome of wounding, surgical or traumatic, is dependent on the interplay of two contrary groups of influences—the disruptive forces and the healing computation. The interaction of these groups formulates the healing equation, the result of which spells success or failure. In any situation where surgical intervention is required this must be taken into account before a wise decision regarding suture technique and material can be made.

THE DISRUPTIVE FORCES

Lythgoe (1960) demonstrated that the majority of acute wound failures, 'the burst abdomen', result from the cutting out of intact suture material, thus signifying that the tissues had failed to hold the suture placement. As we shall see, the type of suture material used in a particular situation can influence this debility, for the greater the tissue reaction to the suture

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the more likely are oedema and inflammatory response to weaken the tissue bite. Premature absorption of suture material appears to be influential in a minority of cases. Dudley (1970) has noted that the pressure of a suture on tissues is inversely proportional to the diameter of the suture material, but consideration has also to be given to the augmented tissue reaction should excessive amounts of suture be used. Howes (1940) described the augmented strength of wounds sutured with large tissue bites. A sufficient number of sutures is required to distribute tension reasonably. A maximum zone of inflammatory reaction with oedema and a resultant weak area was recognized to lie in the 0·5 cm adjacent to the wound edge (Adamson et al., 1966). One-layer closure perhaps affords an appropriate economic compromise to this paradox. Total quantities of material are reduced by avoiding multi-layer closure, but sufficient strength is gained by deeper bites of appropriate strength suture. Mathematical calculations on the suture length required for any wound to allow for oedema and to avoid the certainty of an over-taut wound were formulated by Jenkins (1976), who estimated that the suture length used must not be less than four times the length of the wound to be sutured. Suture material must lie at right angles to the line of tissue fibres, and the risk of sutures cutting out is greater where the direction of suture tension runs with the anatomical line of fibres.

There are special disruptive factors, such as distension, coughing, obesity, debility, malnutrition and age, which require individual assessment when determining the suture technique to be used. The measured surgical response must meet all these challenges.

THE HEALING COMPUTATION

The assimilation of the necessary elements for wound repair, and the subsequent compounding of these elements in the process, may be influenced by factors which modify both the structure and the time required to complete the process. This complex summation of responses, the healing computation, is accountable when the surgeon elects a particular technique or chooses a particular suture material. Our concern is the influence of the suture material on the equation, and careful judgement is required in every situation before a decision can be made, a decision which aims at harmony with biological events.

Introduction of a suture automatically implies fresh trauma, with consequent inflammatory response. The design of the needle and the mechanical abrasiveness of the suture need to be considered. The previously noted inflammatory response in the 0·5 cm adjacent to the wound edge also occurs in the needle track. Release of enzymes from inflammatory cells with collagenolysis and reactive oedema should be minimal to promote secure healing. Tissue reaction to suture material has always commanded attention, and the advent of modern 'inert' synthetic materials has done much to improve this situation. An assessment of tissue reactivity to currently available material in common use is seen in *Fig. 1.1*. Catgut is a foreign protein and

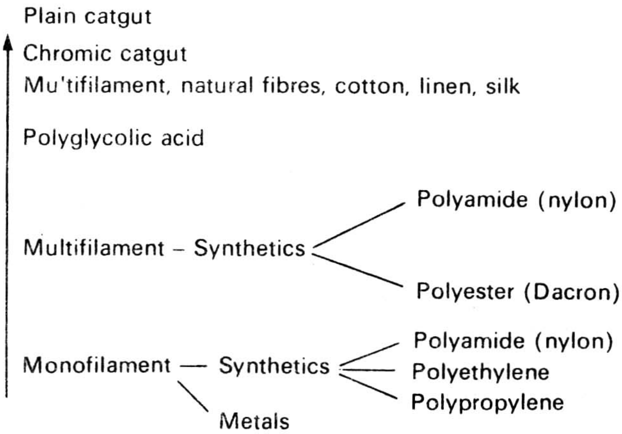

Fig. 1.1 Diagrammatic scale of tissue reaction to suture materials.

the well known reaction to this has been much reduced by modern processing and chroming. Plain catgut still incites a full reaction. The naturally occurring non-absorbables, silk, linen and cotton, are also grossly reactive. Braided polyglycolic acid sutures (absorbable synthetic) produce a fairly minor tissue response only excelled by the monofilaments of nylon, steel, polyethylene and polypropylene (Prolene).

Tissue reaction is proportional to total quantities of any given suture material. Excessive knotting and long 'ends' may constitute a local suture excess and may be counter-productive in terms of total wound security.

INFECTION

The association between infection and the suture material used in a wound has been an important consideration in the surgeon's mind since Lister's antiseptic technique allowed the safe introduction of catgut to the surgical wound. Elek and Conen (1957) showed that the virulence of staphylococci is enhanced 10 000 times when a foreign body is included in the wound. A decrease in tissue resistance must occur to permit the establishment of infection.

Silk and the other natural non-absorbable materials are pre-eminent in establishing, augmenting and maintaining infection and resolution may be achieved only when such a suture is either removed or rejected by the body. Synthetic non-absorbables of monofilament profile are much less dangerous in this respect and indeed infected wounds have been proved to heal satisfactorily in the presence of these materials. Accordingly, they are selected for situations where potential infection is recognized. Their removal is rarely required.

Synthetic materials are marketed in monofilament or multifilament form. The monofilaments have an established position through their inert reaction and relative safety in the presence of infection. The multifilament (braided) forms of synthetics are less satisfactory in the presence of infection. They induce more tissue reaction and their introduction through infected material is known to pick up about ten times more organisms than the equivalent monofilament. Additionally the capillary action of braided material may draw surface infection along the suture track into the wound. Once established, the infection may not be eradicated until the multifilament is removed. Catgut, particularly plain catgut, although monofilament in profile, produces even more reaction. Polyglycolic acid—only produced as a braided suture—induces more reaction than monofilament synthetics, but markedly less than catgut.

Infection, when established, disrupts the healing process. The healing computation may be upset by resultant tissue oedema and fragility with digestion of collagen—both in the tissues and in catgut sutures—by enzymes released from the phagocytic cells. Necrosis and perhaps disruption or late wound weakness may result. In the presence of infection simple taping of wounds to provide approximation, if need be with removal of all buried sutures, may accelerate healing (Brunius, 1969).

During the lag phase of wound healing wound strength depends entirely on sutures. However, no purpose is served by using a strength of material greater than that of the tissues approximated. Indeed Douglas (1949) pointed out that it is the loop strength that must be considered in judging this adequacy. The loop strength is approximately the sum of the linear tensile strength plus the knot strength of the material, and equates with the practical demand that will be made on a suture when tied in the body. Tensile strength of suture material is usually measured using the Instron Tensometer. Knot security has attracted considerable study. Monofilaments generally have a low coefficient of friction and thus the knot may slip. Monofilament nylon is particularly hazardous, Prolene less so. Braiding provides an immediate rise in security. Polyester has a very secure knot, but snags the tissue. Teflon coating has improved the tissue reaction but there is considerably less knot security. Catgut notoriously 'swells' the knot loose. Polyglycolic acid produces a secure knot but a careful technique to lay the knot accurately is required.

Occasional hazards in healing may result from faulty technique such as the over-tightening of sutures with resultant oedema, and ischaemic and devitalized tissues. Most surgeons would agree that surgical technique and the placement of sutures is in every way as important as the selection of the sutures themselves.

It is now appropriate to look at the qualities of the common suture materials which influence the choice in individual procedures.

ABSORBABLE SUTURES

Catgut

Now obtained from the submucosa of the upper intestine of sheep or alternatively the serosa of beef. The submucosal 'casings' are cleaned and split into ribbons which may be chrome tanned with basic chromic compounds. Twisting under tension and drying promotes adhesion. When this has occurred the product is polished to give it a monofilament profile.

Chroming of catgut slows the rate of absorption and this process is now applied to the individual ribbons before twisting, so that absorption has become more uniform. In so doing, chroming also reduces tissue reaction. Plain catgut induces a profound inflammatory response with tissue oedema and leucocyte encasement, obvious within 24 hours. The more severe reactions to catgut described in older literature have been moderated by improved manufacturing methods.

Akin to catgut is extruded collagen, derived from the tendo Achillis of cattle. Homogenized collagen became an alternative sterile source of suture in plain and chromic form. Rather more stiff than catgut, it has mainly been accepted in ophthalmic surgery where tissue reaction to the suture is probably less than the response to catgut.

Absorption of catgut is by proteolytic enzymatic digestion, and the polymorph is probably the principal source of this enzyme. Catgut is usually absorbed in 80–120 days, but occasionally has been found in wounds after three years. Haxton (1963) has reported little catgut strength remaining in wounds sutured with catgut after 8–9 days. There is a great variability of performance, and both the site of use and the size of suture would appear to be important. On the gastric mucosa digestion may be functionally complete within 24 hours (Cassie, 1977) and similar findings may occur in the terminal ileum (Everett, 1970). Because of the reaction which it induces in the tissues and because it is liable itself to attack from enzymes derived from polymorphs, it should not be used in sites where infection is predictable. Nor is it reliable in sites where healing is normally slow, such as the linea alba. The handling of the material is excellent and has commended its use to surgeons. It does not snag on tissues or drag—not an attribute of its synthetic successor, polyglycolic acid. Laying of knots is accurate and initially sound but unfortunately the knot of catgut can swell itself loose. Plain catgut is particularly prone to this defect.

Sterilization can be effected by either gamma radiation or the use of ethylene oxide. Catgut is now packaged in a fluid which ensures that it retains its ideal handling characteristics.

Polyglycolic Acid Sutures (PGA) (Dexon)

This synthetic suture is manufactured using a process which polymerizes glycolide to PGA. The extruded filaments are stretched and braided to form a suture which has a high tensile strength (Howes, 1973). The straight pull tensile strength is about 1·2 times stronger than that of catgut. Knot pull strength performance is even better. PGA loses 28 per cent of its strength on knotting, whereas plain catgut suffers a 53 per cent loss and chromic catgut a 40 per cent loss. Another feature that favours PGA is the absence of strength loss on wetting. Plain catgut loses 39 per cent of straight pull strength and chromic 19 per cent on wetting. Thus in the tissue PGA has the advantage of an initial wet knot strength 1·4 times that of chromic catgut and twice that of plain catgut. PGA knot slippage is rare, whereas catgut is known to swell the knot loose. PGA does not swell. Swelling has the added hazard of exposing an even larger quantity of suture material to the tissues and initiating even greater tissue reaction.

PGA has been reported to retain strength for approximately the same period as chromic catgut. Its greater initial strength would appear to leave it with an advantage at the end of 14 days. Certainly comparative trials of abdominal wound closure have indicated that it compares favourably with monofilament nylon and steel (Leaper et al., 1977).

Absorption occurs between 10 and 90 days after implant and is uniform and predictable by a process of hydrolysis. It is unaffected by the collagenases that are concerned in the breakdown of catgut. Hence the presence of polymorphs which produce the enzyme is not a contra-indication to its use. However, as it is a braided material it induces more tissue response than do monofilament synthetics and produces some foreign body reaction in the infected wound. Where an absorbable suture is required it offers advantages over catgut.

Knot security of PGA is excellent but the knots are rather difficult to lay. PGA is inclined to drag through tissues due to the braiding, and a saw-like action has been described. Alleviation of this disadvantage is obtained by wetting the suture before use. Nevertheless, there are occasions where a monofilament synthetic or catgut may be preferable because of this feature.

Sterilization of PGA is effected by ethylene oxide.

NON-ABSORBABLE SUTURES

Sutures are termed 'non-absorbable' where no enzymatic or dissolution process is actively involved by their presence in the tissues. Many non-absorbable sutures do eventually fragment and are removed. Multifilament nylon loses most of its strength with fragmentation in the first six months, as does silk.

Silk

This material is obtained from thread spun by the larva of the silk worm while making its cocoon. It is a proteinous material. The surface layer of silk albumin is removed as the first step in the manufacture of the suture. The filaments may then be braided or braided over a twisted cord. The product is multifilament in character. A special non-degummed silk known as 'Chinese twist silk' attracted surgical attention by virtue of an augmented reaction with fibrosis. Floss silk is another product with a special loose quality which was believed to encourage fibroblast invasion and enhanced fibrosis.

Silk has always found favour because of its excellent handling characteristics. It knots well, allowing ends to be cut short. Unfortunately it stimulates a marked tissue reaction because of its foreign protein reaction which is only slightly less than that induced by plain catgut. Fibrous encapsulation of silk sutures is found after 2–3 weeks in the tissues. In addition, the twisting and braiding of fibres induces capillary attraction along the suture track and fluid and infection may be drawn into the wound. Waxing of silk reduces this effect and reduces the drag, but creates a loss of knot security. Infection is enhanced and the effects magnified and prolonged by silk. Silk has been noted to lose about 20 per cent of its tensile strength on wetting, an effect also counteracted by waxing. Fragmentation occurs after implantation and all tensile strength has been lost after 6 months. Despite these drawbacks its fine handling qualities have established its position as a yardstick of performance. No weakening has been noted after boiling or autoclaving. In normal circumstances sterilization is by gamma radiation.

Cotton

A cellulose suture of vegetable origin manufactured by twisting the seed hairs of long fibre Sea Island or Egyptian cotton. It is therefore a multifilament suture. Its functional properties are very similar to silk. It also fragments in situ after about 6 months. Surprisingly it gains strength when wet, but it ranks as a rather weak suture. It is cheap.

Linen

Long flax fibres are twisted to produce linen thread. Linen has similar properties to cotton but it is a stronger material. It also gains strength when wet. It has found favour extensively in gastro-intestinal surgery.

Synthetic Non-Absorbables

Polyamides

Better known as 'nylon' and manufactured in mono- and multifilament forms. Nylon is comparatively inert, stimulating a very modest tissue reaction. Braided nylon fragments in the tissues and loses most of its strength within 6 months. The monofilament behaves quite differently, losing only 16 per cent of its strength in the first year. While the braided suture handles well and has good knot security the monofilament has very poor handling quality, and poor knot security due to a low coefficient of friction and a 'memory' which inclines the knot to untie. Braided nylon may prove troublesome in the presence of infection and may require removal. The monofilament, however, is so inert that healing of the infected wound may proceed satisfactorily in its presence. Normally sterilized by gamma radiation, it can tolerate autoclaving (up to three times) without degradation.

Polyesters

Dacron and Terylene are polyesters. They are braided materials with very high and permanent tensile strength. They promote very little inflammatory reactive tissue response, and knot security is normally high. Unfortunately the material is difficult to handle due to an inclination for strands to adhere. This also prejudices placement of the knot. Endeavours to overcome this by applying a coating of PTFE or Teflon succeed in reducing this drawback but a resultant loss in knot security is incurred. Where permanent strength combined with low tissue reactivity is required, as in the cardiovascular field, it has found favour on a major scale.

Special developments of this material have been engineered to meet the requirements of vascular surgery. Endeavours to engage Dacron arterial grafts by an ingrowth of fibrous tissue, subsequently endothelialized, have succeeded and so reduce the risks of late thrombosis. This achievement has depended largely on the development of a polyester velour with a specialized filamentous wall. Polyester is also produced as mesh, felt and knitted fabric with uses in general surgery as well as cardiovascular repair. Knitted fabrics and meshes conform particularly well to a required shape without wrinkling, thus lending themselves well to repair of defects and hernias. Polyester is normally sterilized by gamma radiation but can also be autoclaved.

Polyethylene (Polymerized Ethylene)

This is a strong suture material available in monofilament form. Tissue reactivity is minimal and handling is less difficult than nylon, but these initial advantages are counterbalanced by a progressive loss of strength in the tissues, with eventual fragmentation. It is also produced as a mesh for use in general surgery. Sterilization is accomplished by gamma radiation or ethylene oxide. It melts at 132 °C so that autoclaving is not possible.

Polypropylene (Prolene)

Polymerized propylene is another industrial development. The specialized surgical preparation is a monofilament material which retains its strength permanently. Its tensile strength is high—similar to that of nylon, and does not weaken or fragment. It is amongst the most inert of sutures, infected wounds healing well in its presence. The handling characteristics are less tiresome and hazardous than those of nylon. Absence of 'memory' and the inclination to untie exhibited by nylon facilitates its use. The placing of knots is easier than with nylon, and it is secure on the third throw. It is also available as a mesh for defect repair. The vivid blue dye contrasts well in the tissues, making visualization easy. Avoidance of instrumental damage is important since weakness may be induced. Sterilization is by ethylene oxide or alternatively by autoclaving.

METALLIC SUTURES

Stainless steel, tantalum and silver have established positions in the suture magazine. All are inert and can be used in the presence of infection. They may eventually fragment due to metal fatigue and kinking will accelerate fracture. Knot security is very high but the knot itself may produce local irritation and discomfort. Long ends must be avoided. The dermis is not insensitive on its deeper aspect so that inversion and burying of the knot is required. Handling of metallic sutures requires special techniques but these need not be regarded as a drawback. Mechanical suturing devices exploit these qualities.

Stainless Steel

The alloy of steel with molybdenum, chromium and nickel has been used to produce both a monofilament and braided suture of soft steel, which have very high tensile strength. Shouldice et al. (1961) reported excellent results with minor infection rates in a review of 28 000 hernia repairs using steel wire. The development of a new generation of sophisticated mechanical suturing devices may expand the use of this material in the general surgical field. Repeated autoclaving is accomplished without damage.

Tantalum

This material became noted because of its remarkable resistance to repeated flexion. Tantalum wire combines extreme fine gauge with great strength. Tantalum gauze has proved useful in hernia repair. The material has also been moulded to form plates and rolled to produce a fine foil.

Silver

Once popular since it combined inertness with good handling, it has largely been superseded by monofilament synthetics.

STERILIZATION OF SUTURE MATERIALS (*Table 1.1*)

Three methods are employed: gamma radiation, ethylene oxide and autoclave. Each may affect the suture material properties to some degree.

Table 1.1 Sterilization of suture material

	Autoclave	*Ethylene Oxide*	*Gamma Rad.*
Catgut		†	*
PGA		*	
Steel	*		
Silk			†
Cotton	†	*	
Linen	†	*	
Polyester	†		*
Polyethylene		†	*
Polyamides	†		*
Polypropylene	†	*	

*Method of choice †Alternative

Gamma Radiation

A monitored dose (2.5 Mrad) is used to avoid deterioration of material which can occur in excessive dosage. Linen, cotton, PGA and polypropylene are damaged at the required dosage. It has the manufacturing advantage of applicability to the packaged material.

Ethylene Oxide

The poisonous nature of this gas together with the requirement for packages to be open prior to sterilization makes this choice less attractive. It is the selected method in the treatment of PGA, polypropylene, linen and cotton. It can be used in catgut and polyethylene sterilization.

Autoclave

Readily available but damages catgut, PGA and polyethylene. Silk, linen and cotton can be autoclaved but lose some strength. Polyesters, nylon, polypropylene and metals will tolerate at least three autoclaving procedures.

SOME OPERATIVE IMPLICATIONS

Many guidelines are seen to emerge, but there are no rules.

General Abdominal Closure

Suture material strength is measured in relation to the cross-sectional area. Metals are strongest, natural fibres and materials weakest and synthetics intermediate in strength. Accordingly, suture size will depend on the disruptive forces, the tissue resistance and the material employed.

Supportive sutures should avoid the area of maximum tissue reaction in the 0·5 cm adjacent to the wound. The 'one centimetre plus' bite achieves this and secures the mechanical advantage of a musculo-aponeurotic buffer to the suture (Leaper et al., 1977). Coaptation of the wound is sought by uniform support from an adequate number of sutures rather than reliance on fewer sutures, which may be under excessive tension with consequent ischaemic hazards. An adequate length of suture in the 4 : 1 ratio advocated by Jenkins (1976) is required if the hazard of 'cutting out' is to be avoided, and this concept makes allowance for the appropriate tissue bites. Improvements in incidence of wound dehiscence and late herniation following the introduction of one-layer closure (mass ligature) must reflect these factors (Jones et al., 1941; Goligher et al., 1975). Anatomical difficulties where the suture lies parallel to the tissue fibres—as in the posterior rectus sheath—may be overcome by introducing loop sutures from within the abdomen as a horizontal mattress, thereby off-setting part of the load at right angles to fibre direction.

The material employed must provide sufficient extrinsic support until intrinsic strength meets the disruptive challenge. Chromic catgut can no longer be regarded as reliable in this situation, modern synthetics achieving a better performance. The absorbable polyglycolic acid proves, in practice, to be as effective as nylon polyethylene, polypropylene and steel. Nevertheless in circumstances where healing potential is impaired for any reason, the long-term advantage of a monofilament unabsorbable suture must weigh in its favour.

The 'loop' or double strand suture now available swaged into the needle obviates one of the knotting hazards of the monofilament synthetic. Completion of the continuous sutures with burying of the final knot below the aponeurosis avoids the irritation from 'ends' which may occur in the subcutaneous layer and reduces the likelihood of later extrusion. The use of a multifilament non-absorbable suture in this situation still carries additional dangers of infection and rejection. The calibre of sutures should be of adequate but not excessive loop strength. Ends should not be excessive if wound complications are to be avoided.

Intestinal Anastomosis

The tissue reactive margin which influences general closure has not been defined in stomach or in bowel. Essentially the bite must include the submucosa to achieve security and healing. Tissue reactions to catgut and premature absorption have imposed some limitations on its use unless reinforced by a non-absorbable seromuscular suture layer. Catgut lying in the lumen of the stomach—the haemostatic layer—is known to fail early in a small percentage of cases, the result of acid pepsin digestion. Similarly there appear to be hazards in the ileum and jejunum so that its use in right hemicolectomy, ileo-rectal anastomosis and oesophagojejunostomy may be unwise (Everett, 1970). Colo-colic anastomosis with catgut has proved satisfactory. Polyglycolic acid sutures are reliable in all these areas. Tanner (1951) described ulceration in the stomach where continuous non-absorbable sutures had been used as a through-and-through stitch. This hazard may also occur with interrupted non-absorbable seromuscular sutures eroding on to the mucosa (Kalima and Asp, 1973).

In the biliary field, the avoidance of duct concretions based on suture material requires the use of an absorbable suture. Anastomosis of biliary tree to small bowel may not be accomplished safely with catgut, so that polyglycolic acid, perhaps reinforced by a monofilament which does not penetrate the lumen, is required.

One- or two-layer anastomosis in large bowel appears to achieve very similar results. Where difficulty arises and impairment of blood supply, oedema or obstruction may occur, there seems to be good justification to employ a single layer closure of monofilament polypropylene. Colorectal anastomosis continues to thwart endeavours to produce a reliable and leak-proof anastomosis (Everett, 1975; Goligher et al., 1977).

Suture Size

Metrication is resolving the diverse and illogical system of sizing which became tolerable only through familiarity. The metric gauge recognizes the smaller of the 'limit' figures for a particular size. This figure is multiplied by 10 to give the metric gauge. Thus a suture of diameter range 0·30–0·33 mm would be classified as No. 3 metric (No. 2 for non-absorbables).

The Needle

The needle track histopathology resembles that described in relation to any surgical wound, and similar consequences may be expected. Trauma must be minimized. The design of needles which are swaged to sutures attempts to achieve a maximum technical efficiency with minimum tissue trauma. The range of needles and points has thus commanded as much interest as the sutures they carry.

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