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Mechanical Factors Affecting the Healing of Surgical Wounds

Dr. W. W. Armistead*

IN RECENT years a great deal of attention has been focused on the importance in human surgery of asepsis and antibiotic therapy. This emphasis is entirely justifiable and there is no doubt that it has had a wholesome effect on veterinary surgery. Nevertheless, along with this trend, there has developed a tendency to minimize the importance of the mechanical aspects of surgery. Until the latter part of the nineteenth century the success of surgery depended almost wholly on mechanical excellence. Today much space in current medical periodicals is devoted to aseptic technique and antibiotic treatment. But asepsis and antibiotics have not replaced or superceded mechanical excellence; they have only supplemented it. This presentation will deal briefly with some of the more basic aspects of surgery: mechanical factors which influence the healing of wounds.

The causes of delayed wound healing are many. The most common and, therefore, the most important causes are dietary deficiencies (especially hypoproteinemia and avitaminosis C), senility, obesity, and malignant disease. These are not within the scope of this presentation. However the purely mechanical causes of delayed wound healing—and of that dreaded postoperative catastrophe, wound dehiscence—also are important and numerous. They include: (1) unnecessary trauma during surgery, (2) inappropriate type, size, or number of sutures, (3) unusual strain on the healing wound. Let us consider these three in turn.

Trauma

Although modern surgery is dedicated to the minimizing of trauma, its disciples often fail to carry out this precept in their practices. It is common for a surgeon to point out the merits of his ample incision—to avoid traumatizing the wound edges. Yet this same surgeon may then insert a self-retaining wound retractor into the opening, forcing it open as far as possible. He then repeatedly wipes the drying tissue with a rough gauze sponge and snaps half a dozen or more hemostats on tiny bleeding vessels. Later he quickly (and roughly) replaces these forceps with ligatures of non-absorbable material. In suturing the wound he uses a rat-tooth thumb forceps and pinches dozens of small wounds along the incision edges. Of course all this is done as aseptically as possible. And the wound so managed will usually heal without suppuration. But how much quicker would it have healed with more gentle handling? And might not less trauma have been followed by less pain during healing? The fact that some of the wounds produced by present-day surgeons heal at all is a tribute to the principle of aseptic technique. The successful surgeon of the pre-asepsis era had to be more gentle with tissue. For a clear-cut illustration of the benefits of

*Ed. note: This article was presented by Dr. Armistead at the Nineteenth Annual Conference for Veterinarians held at Ohio State University. Dr. Armistead received his DVM degree from A & M College of Texas in 1938. He became associate professor in 1946 and professor in 1947 at the same institution. In June 1950, he received his M. Sc. in Veterinary Surgery from Ohio State University.
minimizing trauma, study the technique of the plastic surgeon. Of all present-day surgeons he has the greatest respect for gentleness in handling tissue.

One of the most articulate champions of atraumatic surgery is Mont Reid, for years Professor of Surgery at the University of Cincinnati. Here is a quotation from an article which he wrote in 1933: “Sharp dissection with the knife in the belief that it is less damaging to living tissue is the almost invariable rule. The use of clamps on the peritoneum and other tissues for purposes of traction demands an extraordinary excuse. The use of retractors and especially the self-retaining ones is reduced to a minimum. Sutures are tied with extreme care lest their tightness or subsequent tightening due to edema interferes with circulation.”

Sutures

The contribution the sutures make to the healing of a wound is enormously important. For the first four days coaptation of the wound is entirely dependent on the suture. At this time fibroblasts begin to proliferate and help to hold the wound together. However, fibrosis usually doesn’t reach its maximum for 12 to 14 days. For this reason, wound disruptions usually occur between the fifth and twelfth days—most often between the seventh and ninth. This means that in the normally healing wound we need a suture we can depend on for about two weeks after the operation; beyond two weeks there is no need for sutures of any kind.

Research has shown that buried 20-day catgut of some brands cannot always be depended on for two weeks. So-called 40-day chromic catgut more nearly approaches this need. On the other hand, in experimental dogs at The Ohio State University, “medium chromic” catgut sutures in lumbo-dorsal fascia were still intact after three months in several animals. Except in fascia, this situation cannot be materially improved by including in the suture a larger “bite” of tissue. In fact, the resulting tissue strangulation may further lower the holding power by making the tissue more friable. In short, the tensile strength of suture materials need not be considered in suturing soft tissue. What is more important is the size, number, and pattern of suturing.

A small suture is more likely to cut or tear out than is a larger suture. On the other hand, the larger the buried suture, the more it will delay healing—both mechanically and by stimulating more tissue reaction. Too many sutures unnecessarily traumatize and interfere more with blood supply; too few sutures increase the hazard of gaping, disruption, and herniation. Continuous sutures are hazardous where great stress is encountered or in the presence of infection, drainage setons, or excessive friability of tissue; interrupted sutures are time consuming and unnecessarily bulky in areas where no stress is encountered. The through-and-through suture is efficient in closing the average median line abdominal incision; it is undesirable in an off-center abdominal incision or in an obese patient. For best results, the most
appropriate kind, number, and size of suture should be used for each wound. One method of closure cannot be used for all wounds any more than one medicine can be used for all diseases.

Here are a few facts to be remembered in choosing the appropriate suture for a certain wound:

1. Knotting weakens suture. The strength of a knot is about 70 percent of that of the intact strand. The way a knot is tied is important, too. Tying the so-called surgeon’s knot may seriously weaken the suture by the sawing action necessary to tighten it. Also undependable is the knot used to end a continuous suture—the one in which two strands are tied to a single strand.

2. Wetting (placing in tissue) also weakens suture. This is most notable in the case of catgut which may lose 30 per cent of its dry tensile strength by wetting.

3. The functioning strength of suture is equal to its dry strength minus (1) and (2), above. The functioning strength of No. 0 catgut still is greater than the holding power of fascia.

4. The holding power of soft tissue depends on its fibrous tissue content.

5. Cotton, size for size, is two-thirds as strong as catgut and three-fourths as strong as silk. Few surgeons realize that dry catgut is stronger than either cotton or silk.

Strain on the Wound

As has been mentioned before, many factors are involved in causing wound disruption. Most of these are indirect causes. The principal immediate or exciting cause is a mechanical one—strain on the healing wound. In the case of abdominal wounds, vomiting and coughing are notable hazards. In particularly weak abdominal wounds, tensing of the muscles in arising or in defecation may also play a part. The importance of the protrusion of omentum into peritoneal gaps (the “omentum wedge”) as a predisposing factor in abdominal wound disruption has probably been overplayed, as has been the value of bandaging in preventing evisceration. Bandaging, of course, may deter some animals from chewing or licking at their wounds.

A simple means of speeding wound healing (and avoiding disruption) is to apply the principle of splinting to all surgical wounds. Because bones heal slowly, the importance of immobilizing fractured bones is obvious. Similarly, in soft tissue wounds immobilization leads to quicker healing. Everyone is familiar with the fact that a wound over a finger joint will heal faster if the finger is splinted. The same fact applies to abdominal wounds or any other soft tissue wound.

In small animals, one of the things which delays healing of the median-line abdominal wound is its tendency to wrinkle or double over when the animal assumes a sitting position. This tendency may be overcome by placing over the bandage a cardboard splint which is strapped to the animal with adhesive tape, completely encircling the body. The longer Caesarian wound may be bandaged without interfering with nursing if a tongue-depressor splint is similarly used. The tongue depressor may be cut to the desired length and held in place with tape straps passing between the teats. In changing these splint-type dressings the tape need only be divided on one side of the splint. The splint then may be folded back, the wound inspected and treated, a clean gauze pad applied, and the splint replaced with short tape strips over the top of the original tape.

I have no desire to minimize the importance of asepsis or pre-operative and post-operative therapy. However, I hope that by this presentation I have stimulated some thought on the importance of mechanical excellence in surgery. Just as the practitioner of medicine should know the appropriate dosages of the drugs he administers, so should the surgeon know the strengths of the tissues and materials he works with. Certainly the use of too few or too small sutures is at least as dangerous as the administration of too little penicillin. And while the results are not so obvious, an overdose of suture is
just as serious a fault as an overdose of castor oil.

I suffer from the snow and wind
But utter not a whin.

When hunger pangs
Invade my girth,
Pulling heavy feed,
I have no means to help myself,
Not to a single seed.

Sad loneliness
Is terrible
To humans with minds so able.
But I can neither walk nor think
While tied in a dusty stable.

The worst of all
Is when I'm sick,
—A vegetarian
So predisposed to colic; — help!
—Veterinarian.

During the period 1949 to 1950, two cases of avian pneumoencephalitis (Newcastle disease) were reported in man.