SURGERY OF THE HAND*

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The mobility and the strength of the hand are dependent on a great detail of anatomical structures. Bones, joints, ligaments, long and short tendons with their pulleys and sheaths, short muscles, nerves, blood vessels, and the skin, are all packed within this small space between fascia and areolar tissue. The latter is the gliding material that allows one structure to move unhindered on or with its neighbour.

The function of the hand can be almost completely lost by the replacement of this gliding material by scar tissue. This is best illustrated in a hand caught between rollers and suffering from extensive skin injury and the deeper wounds of serious fracture dislocations. Although the fracture dislocations may be immediately reduced and the skin cleansed and repaired, the subsequent *superficial* and *deep* scar tissue may completely cripple the hand, although the rest of its anatomy is in continuity.

Looking for a section within surgery of the hand that I could cover within my time limit, I have chosen the prevention of scar tissue.

Since hand infection is the major cause of scar tissue its prevention is the first consideration in all repair surgery of the hand.

The hands are the most exposed parts of the body. As the result of their exposure and the jobs man and the devil put them to, the intact skin of the hand is continually contaminated by a wide variety of pathogenic organisms. For example: In the act of blowing the nose or coughing the contaminants are the naso-pharyngeal streptococci and staphylococci; in another physiological act they are the coliform group; on the muck-stained hands of agricultural workers or gardeners they may be the anaerobes of gas gangrene or tetanus.

When the skin of the hand is broken these contaminants are driven into the depths of the wound. The wounding instrument itself is *generally* bacteriologically clean—at least, the presses, the capstan lathes and the other tools we swabbed in industrial Birmingham were so. But the wounding instrument plays an important part in the story of hand infection, not only by the division and displacement of important hand structures and the creation of dead spaces, but equally important by the damage it may cause to the blood supply of these and neighbouring structures.

Forty years ago Almroth Wright believed that most of the evils of septic infection could be prevented if the wound could be quickly brought to a clean condition, in which healthy leucocytes could cope with any remaining contaminants and the wound could safely be closed. More recently the research of Ashley Miles and his colleagues has proved that the major factor in the prevention of infection is that the circulatory response of the wounded tissues *within the first hour* of injury should bring up a sufficiency of leucocytes and specific antitoxins to aid the effective elimination of the contaminants. This is the basic knowledge upon which we now base our repair planning and our surgical techniques. The picture emphasizes not only the urgency of surgical intervention but also its primary objective, namely, to handle all damaged tissues gently and by surgical measures to improve the blood supply of the wounded area.

TREATMENT OF HAND INJURY

Immediately after a hand injury the first step is a preliminary clinical and radiological examination and the formation of a plan for functional repair. This is followed by the application of a good cover dressing to prevent added infection whilst the patient awaits operation.

Under general anaesthesia a further examination of the hand injury is made in which the detailed plan for repair is finalized. This is followed by a thorough but very gentle washing of the whole hand and the forearm by the surgeon himself. This washing involves the most gentle handling of all damaged tissues. After cleansing, a pneumatic tourniquet is applied; the usual aseptic precautions are taken and the operation commenced. The surgery of the hand is unhurried, gentle and precision work. To achieve this standard the bloodless field provided by a tourniquet is as important as a high standard of anaesthesia. I prefer a fully anaesthetized patient. The amount of repair undertaken at the first operation must be left to the judgment and the abilities of the surgeon. For my part I like to hold the tourniquet time down to 1 hour, for I believe that the longer a wound is exposed under a bloodless field the higher the risks of infection.

The all-important objectives at the initial repair are the removal of foreign bodies, dead tissue and badly devitalized tissue. This is restricted to a minimal excision of tissue,

* Based on an address delivered at a plenary session on 'The Surgery of Repair' at the South African Medical Congress, Durban, September 1957. Mr. Gissane's address was illustrated by a number of lantern slides.

particularly of the skin. The next objective is the elimination of all dead spaces; this is frequently achieved by the reduction of badly displaced fractures and dislocations. To these may be added (at the surgeon's discretion) the repair of divided deep tissues such as tendons and nerves; such repairs demand a very high degree of technical craftsmanship. Finally the skin should be closed either by direct suture or by skin graft. The only exception to the skin-closure rule is in the bursting type of injuries without skin loss, in which the tension of sutures may further devitalize the skin. Closure of the wound in such injuries is by light-pressure cover dressing. Finally the hand is immobilized in a position of function, the whole hand being covered, leaving only the tip of the thumb exposed to check the circulatory responses.

Skin Sutures and Skin Grafts

The techniques of skin suture and the choice of skin graft are important technical matters. Skin suture must be accurate and never under tension, and the sutures must be placed in parallel and evenly spaced, leaving no superficial or deep dead space. In the repair of other divided tissues in the hand—for example, nerves or tendons—the same principle of careful surface-to-surface apposition and the avoidance of dead spaces between the divided ends is all-important. The methods of placing these sutures will differ according to the structure under repair.

The type of skin graft chosen to make good a skin defect in the hand is an equally important technical consideration. If the only objective is to avoid added infection then a split-skin graft of a thickness suitable to the site is the safest and best graft of all. If, in addition to skin cover, the purpose is to bring an additional blood supply to the wounded area and also to provide a new gliding material for the underlying tissues, then the method of grafting must be either by local flaps for small skin defects or, for larger defects, by flaps taken from more remote areas.

It should be noted that the defect to be covered by local flaps is achieved by moving skin from the area immediately adjacent to the wound. The blood supply of this area is often damaged by the violence of the wounding, and if it is further damaged by surgery it may die. Local skin flaps at the acute stage of injury must therefore never be lifted unless their blood supply is quite normal.

Flap grafting, both local and remote, when properly used in acute hand injuries, gives very good skin cover, immediately brings a new blood supply to the wounded area, and is a method of choice if later surgery for the repair of deep structures is contemplated.

SCAR TISSUE

The avoidance of deeply placed scar tissue, particularly after closed hand injuries, depends upon a better understanding than we have now of the detailed anatomy of the injury under treatment. Once we have this knowledge we shall be better able to assess the relative methods of so-called conservative treatment against the benefits and the hazards of open repair. For example, the loss of finger movement is not unknown after a closed dislocation of the proximal interphalangeal joint. In such a injury the capsule of the joint must be torn and the tear may extend into the common flexor sheath. If after closed reduction the displacement of these soft tissues remains, then an excess of deep scar tissue may bind down the flexor tendons to the wound of the joint capsule. Because this happens on occasions it would not be profitable to operate on all closed interphalangeal dislocations. Yet there are definite indications for open repair of such injuries. and there are many closed and open injuries of the hand where the surgery of early accurate repair of deep tissues is necessary.

It is my experience that operations on deeply seated scar tissue in the hand, months and years after the initial injury, are always difficult and never completely successful.

Reviewing, some years ago, our Birmingham experience in the treatment of all types of injury to all parts of the body, I was not unduly surprised to learn that the severest types of hand injury involved a period of absence from work which averaged 275 days from the date of injury to the return to some type of gainful employment. This was a longer average time for treatment than that involved by injury to any other part of the body.

BASIC FUNCTIONS OF THE HANDS

In the past we have often wasted a great deal of time and run very considerable risks of dangerous complications in severe hand injuries by following the old rule of saving everything that had a chance of living. A viable finger with multiple fractures and tendon and nerve injuries can at best be completely stiff as the result of inevitable scar tissue but —what is worse—this stiffness frequently interferes with the movement of the neighbouring fingers and considerably delays the functional recovery of the hand as a whole. Now our plan in multiple hand injuries is to save fingers that have a chance of useful functional recovery. This way of thinking simplifies what at first sight may look an impossible repair problem. Using it, we now very seldom amputate the hand, for we believe that almost any functional hand remnant is an improvement on an artificial hand or any type of arthroplasty.

When planning the repair of a badly mutilated hand we come back to the hands' basic functions:

First, the hand is the body's sensitive antennae, a man with both hands amputated appreciates this.

Next, it is a pincer. The retention of any part of the thumb and any remnant of a finger if one or both are fully mobile will achieve this most important function.

The hand is also a hook with which to carry and handle things. I have retained the hand of a young girl with the little finger its only active digit. This patient has been a two-handed telephone operator now for many years.

The hand is also a vice to hold things firmly and for this purpose it requires as little as two fingers and most of the thumb.

Finally, the most primitive form of the hand is one in which it is used as a clamp to hold things down. If the clamp has good sensitive skin cover it is a worth-while tool. This function can be achieved with only the base of the hand.

Major hand injuries are almost exclusively a problem of industrial injury. Workmen are not as interested in the appearance of their hands as in their useful function. Indeed it is not an uncommon experience for a workman to demand the amputation of fingers after extensive surgery that has ended to the complete satisfaction of the surgeon. Finally, our experience with severe hand injuries is that the average workman will not stand up to a long series of repair operations. Indeed, at the end he will often put the repaired hand in his pocket, or in someone else's pocket, and keep it there.