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REPAIR OF INJURIES TO THE TENDONS OF THE HAND

BY

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In our country, Pirogov as early as the middle of the nineteenth century demonstrated experimentally the role of haemorrhage within the tendon sheath in the regeneration of damaged tendons. He was the first of many to contribute to the study of the circulation in relation to problems of regeneration and repair of tendon injuries.

During the last thirty-five years improvements in the surgery of tendon injuries have been made by Janelidse, Girkoloav, Rufanov, Gorinovskaya, Nikilaev, Rosov, Priorov, Kotschergein, Bogdanov, Grigorieva, Weinstein, Nikiforova, and others. They have studied the methods of foreign authors, and particularly of Bunnel, Iselin, Allen, and Mason. With this as a basis there has been issued a guide to surgeons on the treatment of these injuries related to factors such as the site, type of injury, and occupation of the injured worker. A number of points remain in dispute, but we believe that certain general principles have been agreed. I will attempt to outline our policy as concisely as possible.

If it were possible to exclude mistakes at the time of primary surgery in all medical institutions it would certainly greatly decrease the number of difficult problems of tendon repair, which so often lead to unsatisfactory results. The first condition for success in the treatment of tendon injuries is the availability of qualified surgeons able to carry out the necessary technical procedures immediately, carefully, and gently, in a well-equipped operating theatre, following early admission to hospital. The organization of the Health Service in the Soviet Union has endeavoured to make such treatment widely available.

We have put particular emphasis on the organization of the surgical care of industrial injuries. Every industrial plant includes a health department with a surgery for traumatic cases, and hospital beds are available day and night. This organization primarily means that surgery can be carried out within two hours of the accident. The operating surgeon retains responsibility for the patient until recovery is complete.

This report is based on the results of operations on tendon injuries of the wrist and fingers in 375 patients (see Table I). Special attention is paid to industrial injuries as shown in Table II. It will be seen that only 28 of a total of 123 patients had isolated injuries of the tendons, the remaining 95 had accompanying extensive

TABLE I.—Summary of Data of Soviet Surgeons on Primary Tendon Suture

Author	Year	No. of Cases	Site		Good Results (%)	
			Flexors	Extensors	Flexors	Extensors
Weinstein ..	1936	71	26	45	42	80
Svigaskaja ..	1938	131	76	55	81	82
Atanov ..	1939	83	34	49	82	67
Michelson ..	1939	92	92	—	40	—
Choranov ..	1941	40	24	16	83	100
Grigorieva ..	1948	106	49	57	65	95
Lebedev ..	1951	70	45	25	64	100
Rosov ..	1951	444	189	255	71	86
Bogdanov ..	1953	355	167	188	75	89

TABLE II.—Types of Industrial Injuries to Tendons of the Hand

With fracture	43
Isolated injuries	28
With fracture and defects of soft tissue	19
With soft tissue defects	19
With damage to nerves and blood vessels	7
With injury to joints	7

123

skin defects, fractures, or nerve lesions. These complications must be taken into account in evaluation of our surgical technique.

Primary Suture

As a first-aid measure we insist on the immediate immobilization of the hand, with the fingers flexed into a fist for damage to the flexor tendons, and with the fingers extended in rupture of the extensors. This prevents retraction of muscles and torn tendon ends and facilitates primary surgery.

The role of surgery is then to transform the accidental wound into a surgical wound. Operating early with adequate assistance, we aim at accurate suturing of damaged nerves and tendons. This is followed by accurate skin apposition or grafting. Fractures are immobilized in the required position. Primary and accurate surgery during the first hours after injury can make a great contribution to the results obtained in these injuries. Primary suture of tendons restores the anatomical relations of the tissues; it removes a situation in which abnormal nerve impulses are engendered by the damage; it contributes to the re-establishment of normal physiological interrelations between the central nervous system and the local motor apparatus; and it predisposes to early recovery of function without rigidity or contracture.

Primary suture, if antibiotics are available, is in our opinion indicated for all tendon injuries when an experienced surgeon is available, except in the "no-man's-land" area. Outside this zone there are absolutely no contraindications to primary suture even with fractures or skin defects, unless associated with severe disturbance of the circulation. The results of treatment depend not so much on the extent of the damage as its site.

We do not agree with those authors who state, "Repair in 'no-man's-land,' from the middle palmar crease to the middle finger crease, as a rule must be secondary." Primary suture within this zone is permissible, particularly in clean-cut incised wounds, if the hand has been at once correctly immobilized. We have rejected tendon sutures on the palmar surface with silk, and use capron. We permit the use of silk in the reconstruction of extensor tendons. Primary suture is not indicated: (1) If the surgeon is in any doubt about the efficiency of its use in the "no-man's-land" area. (2) In flexor tendon injuries in this region if the accident has occurred with the fingers flexed. In these cases, search for the retracted tendon ends necessitates a larger incision, with damage to the gliding mechanism. Suture is not desirable within the fibro-annular pulleys of the palm and phalanges. (3) In extensive injuries of palmar soft tissues or fractures of the distal part of the metacarpals or proximal phalanges with displacement.

Primary suture in isolated rupture of the profundus tendon over the middle phalanx distal to the bifurcation of the sublimis may be carried out by direct suture.

In injuries of the long flexor to the thumb, the proximal end can usually be found between the two heads of origin of the short flexor. Where suture cannot be carried out here, free grafting will be necessary.

It is well known that the results of primary tendon suture vary with the mechanism of the injury. When the palm of the hand has been damaged by falling on a sharp cutting object with the fingers extended, the proximal end of the tendon, although displaced to the base of the palm, can be found and confidently sutured. In injuries to the palm with the fingers closed into a fist, as, for example, in grasping the blade of a knife, the distal end of the tendon retracts, primary suture is difficult, and its results are less satisfactory.

Most of these operations are carried out by us under local analgesia without a tourniquet, or under intraosseous analgesia with a broad pneumatic cuff. Careful use of this method can prevent the formation of a haematoma. Esmarch bandages are not used. Occasionally we operate under inhalational anaesthesia.

The technique of suture must be speedy, simple, and stable. To be stable the tendon must be crossed without damaging its circulation. The suture must be countersunk in the tendon so that only a minimal amount is left on the surface to interfere with gliding. We use a modification of the method described by Cuneo.

Primary tendon suture has given excellent and satisfactory results in 75% of flexor and 89% of extensor tendon injuries.

Delayed Suture

The second group comprises those in whom primary suture has not been carried out. These cases have been operated on 21 to 45 days after injury, when the inflammatory reaction has settled; occasionally later. In the majority we have succeeded in uniting the severed tendons by delayed suture, and only occasionally have we required to use grafts for injuries in the "no-man's-land" area or beneath the carpal ligament. If problems of skin cover do not interfere, the earlier we operate the easier is the operation found to be and the better its results. In our experience, with early surgery, the dense adhesions between the retracted ends of the tendons and the intermediate structures had not yet formed. Good mobility of the joints is one of the conditions which determine the success of surgery. Only on two occasions (on the 29th and 57th days) have we found extensive fibrous thickening with involvement of the tendon in deep scarring. We have excised these scars as is our practice in Dupuytren's contracture. We have then isolated and sutured the deep flexor proximal in the "no-man's-land" area, using a capron suture.

Where there has been delayed healing of a laceration of the palm or the fingers with extensive scarring we do not rush into reconstructive surgery. We use physiotherapy, including baths, to restore movement and circulation to the skin. Three days before operation we clean the operating field and keep the hand in a sterile bag. We have found it very necessary to remove damaged scarred skin in the palm, and to replace it by some form of plastic procedure, in order to obtain satisfactory results in tendon repair. It is well recognized that secondary repairs to flexor tendons in the zone of "no-man's-land" are very difficult, particularly where the pulleys are destroyed.

Our incisions run parallel to the palmar crease and are curved to the base of the hypothenar eminence. When both ends of the injured tendon or tendons have been located, the distal tendon with its scars may be removed from the sheath and from beneath the pulleys without damage to the annular ligament. We use special instruments designed by Rosov. The freed channel is filled by a free graft derived preferably from the long extensor of the third or fourth toe.

The paratenon is preserved, and is prevented from displacement by a stitch. The graft must exceed the length of the "no-man's-land" area. After extraction of the

FIG. 1.—Method of suture of distal end of flexor tendon graft.

graft it is sutured at the distal end to the bone of the distal phalanx. A wedge is cut in the distal tendon reaching to the bone. With the finest possible awl two holes are made which perforate the bone to the dorsum. The graft is then sutured to the bone by a stitch which is tied over a dorsal bolster of gauze. The sides of the wedge of the distal tendon are then sutured to the graft as described by Allen (Fig. 1). The stitch is withdrawn after three weeks.

The proximal graft is sutured side by side to the proximal end of the deep flexor tendon. Where both tendons have been injured we are convinced that only profundus should be sutured. In patients with multiple injuries to flexor tendons we operate by stages; firstly by repairing the tendons of two fingers only, and delaying reconstruction of the remaining tendons to a second stage. In cases of destroyed annular ligaments, Rosov, Dubrov, and Nikolaeva reconstruct them with free fascial flaps or by transplants from the extensor tendons of a toe. We have no personal experience of this method, and use a flap from the underlying lumbrical muscle.

In 25% of primary operations we have had good results with nearly full flexion and adequate extension. In 50%, flexion was adequate but not full. When the patient was not satisfied with the end-result because the tip of the finger did not reach the palm, we proposed a second operation—arthrodesis of the distal joint in 25 degrees of flexion. By

this means we improved the end-results in seven patients. The others refused the secondary operation and adjusted themselves to their work.

In the repair of tendons beneath the carpal ligament we usually use free grafts. If the median nerve is divided we suture it at the same time. In late cases with multiple damage to the tendons in this area we have sometimes been

obliged to excise the carpal ligament in order to envelop the tendon suture with loose cellular tissue.

Considerable attention has been paid by us to injuries of the extensors of the proximal interphalangeal joints. The patient loses the capacity to extend the middle phalanx, and the shortened muscles provoke hyperextension of the distal phalanx. We have attempted to repair this by a method worked out by Weinstein (Fig. 2).

A long curved incision reaching to the middle of the base of the phalanx exposes

FIG. 2.—Pathology and treatment of injury to the extensor of the proximal interphalangeal joint.

the extensor aponeurosis over the proximal joint. The proximal aponeurosis is dissected out so as to define the lateral bundles. These are approximated with the finger in extension, with five or six fine sutures. The proximal stitches include not only the lateral bundles but also the middle bundle of the long extensor (Fig. 2).

Post-operative Treatment

After tendon repairs it is necessary to immobilize the hand in plaster for four weeks, to prevent retraction of the sutured tendon ends. Following repair of the flexor tendons, the plaster is applied to the back of the hand and forearm to stabilize the fingers in a position of flexion. In injuries of the extensor tendons the splint is applied to the palmar surface with the fingers extended.

The hand is elevated for three to four days after operation. Stitches are removed on the 9th or 10th day, and the patient is discharged from hospital. From the 21st day movement of the fingers is allowed. After six to eight weeks the patient returns to light work, progressing gently to full work after three months.

Aftercare includes physiotherapy and baths, started from the 15th day. The patient also receives corticotrophin, which we have found to help in preventing scar formation and in the absorption of scarring around the repaired tendons. The surgeon who has carried out the operation must keep his patient under personal observation, and should certainly see him at least twice a week. At the end of the third week the surgeon must direct active exercises, with gentle use, to ensure the best possible function.

Conclusion

In extensor tendon injuries, plastic repairs have given satisfactory results in 85% of the patients. Tendon repair on the palmar surface has given satisfactory results in 77%, including 65% in the area of "no-man's-land."

INCISION FOR GALL-BLADDER SURGERY

BY

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The two incisions generally used for operating on the gall-bladder are the right upper paramedian and Kocher's incision. The paramedian incision is often chosen when the costal angle is narrow, and Kocher's when the costal angle is broad.

Kocher (1895) described his incision as an obliquely transverse incision 10 to 15 cm. long, made at a distance of 4 to 6 cm. from the costal margin. As generally carried out in this country it is 2 to 3 cm. from and parallel to the costal margin, care being taken at its lateral extremity to spare the ninth costal nerve. I was deterred from using Kocher's incision by seeing post-operative scar herniae after its employment, but for the past seven years have utilized with increasing frequency a modification which has the advantage of dividing the rectus sheath in the direction of the fibres of its main component—namely, the aponeurosis of the internal oblique. As a result, any straining after operation by tensing the external and internal oblique and transversalis abdominal muscles tends to approximate the fibres of the rectus sheath. It is essentially a muscle-splitting operation so far as the rectus sheath is concerned and so is easy to close, and the stitches do not subsequently cut out. Compared with any vertical incision the patient is far more comfortable after operation, breathing, bending, and moving easier. Normally, patients get out of bed the day after operation. I have never seen a scar hernia follow its use.

Technique

The incision (Fig. 1) is from the midline, one handbreadth— $3\frac{1}{2}$ in. (9 cm.)—above the umbilicus to the tip of the tenth right costal cartilage. In some fat patients there is a natural skin crease in this line which can be utilized. The skin,

FIG. 1.—The line of incision.

the subcutaneous tissue, the anterior rectus sheath, and the rectus muscle are divided in the line of the incision as far out as the outer border of the rectus abdominis (Fig. 2). The medial two-thirds of the posterior rectus sheath with the underlying peritoneum is cut in the same line, then the transversus abdominis is split laterally in the direction of its fibres.

When cutting the fibres of the rectus muscle, branches of the superior epigastric require ligation one-third and two-