THE UNIVERSITY OF ZAMBIA
SCHOOL OF MEDICINE

OUTCOME OF A TWO YEAR PROSPECTIVE STUDY OF FLEXOR TENDON REPAIR OF THE HAND AT THE UNIVERSITY TEACHING HOSPITAL LUSAKA

BY

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A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE MASTER OF MEDICINE (SURGERY) DEGREE OF THE UNIVERSITY OF ZAMBIA

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APPROVAL PAGE

This is to certify that this dissertation is now ready for examination.

Date: 25th June 2000

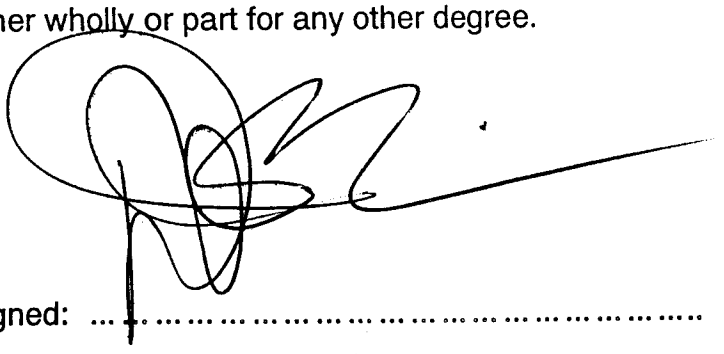
Signed: .....

Date: 23rd June 2000

Signed: .....

DECLARATION

I hereby declare that the work presented in this study has not been presented either wholly or part for any other degree.



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DEDICATION

To all those who helped in any way.

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Finally, my wife Sylvia and children (Makasa and Taonga) for forgiving me for neglecting my family duties and the great help and encouragement they gave me in the course of writing this paper.

ABSTRACT

A two-year prospective study of Flexor Tendon repair at the University Teaching Hospital (UTH), Lusaka is presented. A total of 20 cases were seen in this period, with a total of 71 tendon repairs. Results were graded using the White (1956) and Boyes (1947) criteria: 4 patients were graded as excellent ; 7 Good ; 7 fair and 2 Poor .

The pattern of results compares well with results from other centres where Flexor Tendon repairs of the hand is carried out, showing Zone 2 (No man's land) repairs giving the worst results.

Reference is also made to the importance of the Anatomy when considering repairs of the flexor tendon in the hand as well as practical Surgical approach to this subject.

INTRODUCTION

The University Teaching Hospital (UTH) is situated in Lusaka the capital city of Zambia. The Hospital has a 2000 bed capacity and serves as the main referral Hospital for the country. Lusaka has a population estimated to be 2,000,000. At the University Teaching Hospital all referred cases of tendon injuries are initially managed by the general surgical units, which have other priorities in terms of management. Tendon injuries are therefore neglected to a second priority and often takes weeks before proper treatment is given. Even in cases were treatment has been carried out follow-up of a patient who has undergone tendon repair is very poor (departmental monthly surgical audit reports 1990 –98). In the same period mentioned, the departmental surgical audit reports do not show outcome of repair and most patients are lost to follow-up.

60% of those patients initially seen by the general surgical units end up being referred to the orthopaedic unit as a result of poor initial results.

As much as 30% of the tendon injury repairs carried out by the orthopaedic unit are direct referrals from various health centres around the country. Some referrals come with the history of more than six months after injury.

This is a two-year study, which has been undertaken in the orthopaedic unit in conjunction with the physiotherapy department, studying, and flexor tendon management at UTH.

Data obtained from the surgical mortality and mortality and morbidity audit (1990 – 98) revealed an average of 11 tendon repairs yearly.

STATEMENT OF THE PROBLEM

Flexor tendon injuries of the hand require careful planning and expert management at all levels.

The anatomy of the flexor aspect of the hand dictates that a meticulous protocol needs to be followed to achieve desirable results.

The problem faced at the University Teaching Hospital is delayed and prolonged surgery, inadequate supervision, physiotherapy and review periods.

AIMS AND OBJECTIVES

1. To study the pattern of flexor tendon injuries presenting at the University Teaching Hospital with a view of documenting the current trends of management.

2. To identify problems associated with management of flexor tendon injury.

3. To set up a protocol that may help improve current management of flexor tendon injuries at the University Teaching Hospital.

LITERATURE REVIEW

Historical Aspects

Flexor Tendon injuries were already treated in antiquity by Hippocrates, Galen and Avicenna. Since the Renaissance Surgeons have attempted to repair flexor tendon injuries. Due to the problems related to unsuitable materials and ignorance of the basic rules of asepsis and the absence of antiseptic techniques, very few tendon repairs were successful. Early successful tendon grafts in man were performed in 1910. Brunnel[1] (1910) published his series of grafts and described in detail the anatomical physiological and technical principles to be respected. Brunnel[1], in 1918, developed various pullout direct suture operations but faced problems with adhesions, he abandoned this technique and proposed not to repair Flexor Tendons in the digital tunnels but to graft them. He defined the famous Zone he called 'No Man's Land', which subsequently became Claude Verdan's Zone 2 in 1959.

In 1960, Verdan[2] published his first series of sutures maintained by 2 pins in Zone 2, with comparable results to those obtained after grafting. In 1967, Kleinert[3] with his method of mobile suture became the leader of direct tendon repair in Zone 2, which method is presently in force today.

The question of how to maintain the integrity of tendon repair and how to avoid adhesions has been a subject of great concern, since results of repair lie mainly on post-operative movement.

Anatomy of the Flexor Tendons in the Hand

The digital canals, in which the flexor tendons of the fingers have their course, are constricted zones starting at the level of the metacarpophalangeal joints of the four fingers. The canals are characterised by the presence of fibrous sheaths, particularly well developed opposite the proximal phalanx and middle phalanx but much weaker at the level of the joints, with some significant strengthening elements, the cruciate and oblique ligaments. These digital fibrous sheaths, acting as pulleys, maintain the tendons against the bone surface without compressing them. The synovial sheaths facilitate gliding of the fingers. Each synovial sheath, of connective tissue, forms a visceral layer or epitenon adhering closely to the tendon and a parietal layer lining the wall of the fibrous sheath, separated by a synovial space. The visceral layer has extensions into the inside of the tendon. These are the endotenon, a series of septa separating the fibre bundles from each other. Just before the end of the flexor tendons, a mesotenon of triangular shape joins the two layers of the synovial sheath, acting as a mesentery for the passage of vessels. Other more attenuated structures, the Vinculum brevia and Vinculum longa, perform the same function.

In brief, the epitenon, mesotenon and the vincula enclose a significant number of vessels. The tendons, covered by the visceral layer of their synovial sheath, end at the base of the distal phalanx in the case of the perforating tendon (deep flexor) and on the middle phalanx in the case of the perforated tendon (superficial

flexor). On the palmar surface of the middle phalanx the two halves of the perforated tendon decussate to form a chiasma.

The Blood Supply of the Tendons

After Koelliker[4] (1950) it was accepted for some time that adult tendons were structures without vessels whereas young tendons were vacularised. Nutrition was believed to take place by diffusion from the synovial fluid in the synovial sheaths or from the interstitial fluid of the neighbouring connective tissue. Sappery[5] (1866) demonstrated, in most cases by means of vascular injections, that the vessels destined for the tendons had their points of origin and entry in various places: the musculotendinous junction, the osteotendinous junction joining the extrasynovial regions of areolar tissue with paratenon and in the synovial regions, in the constricted areas with synovial sheaths, in mesotenons and vincula. According to Edwards & Brockis[6] there are intrinsic intratendinous, interfascular vessels exhibiting an internal pattern of longitudinal vessels joined by transverse anastomoses making their way through the interfascilar connective tissue (endotenon). When the vessels have been injected through the ulnar artery with gelatine containing Indian Ink, they can be observed with the naked eye, with a magnifying glass and, if necessary, under the microscope.

Zones of the Hand

Due to the structural peculiarities of the hand at the tip of the distal 1/3rd of the arm, Kleinert H.E [7]and others (1973) divided the hand in zones (Figure 1a).

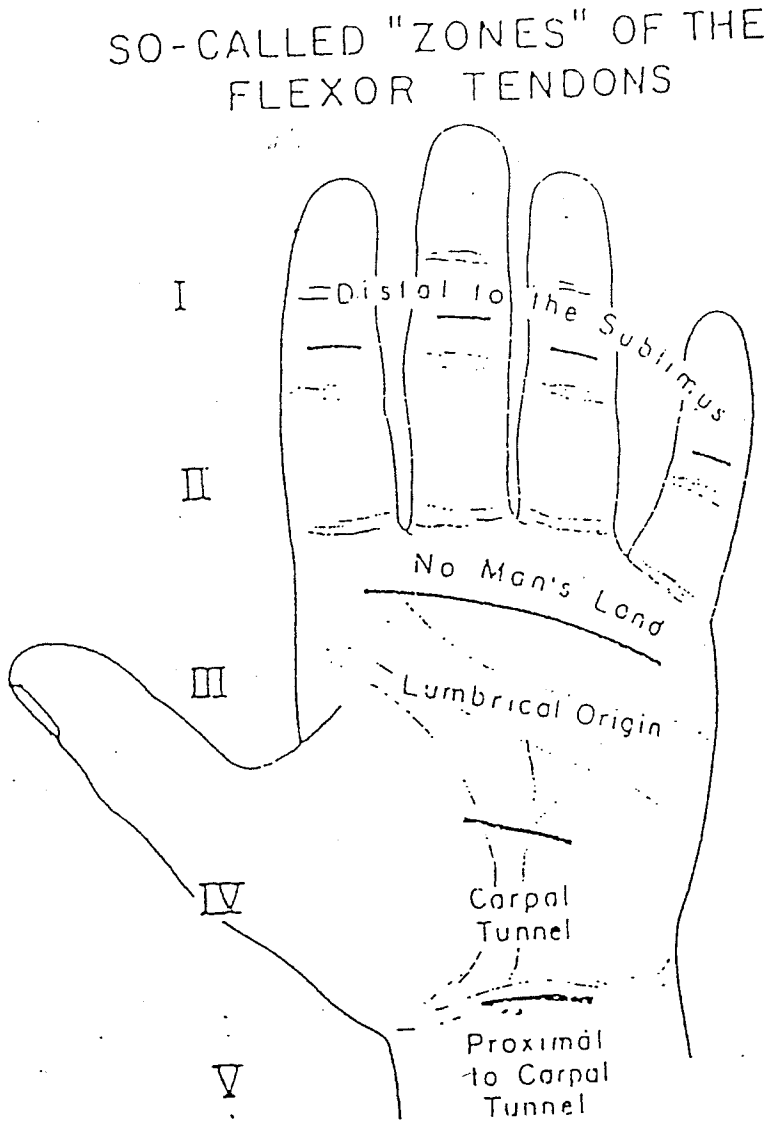

Figure 1 a

'Zones' of the flexor tendons (from Kleinert, H.E, et al, (1973) Primary repair of flexor tendons. Orth. Clin, N. A., 4, No. 4, 866. Courtesy W.B Saunders Co., Publ..)

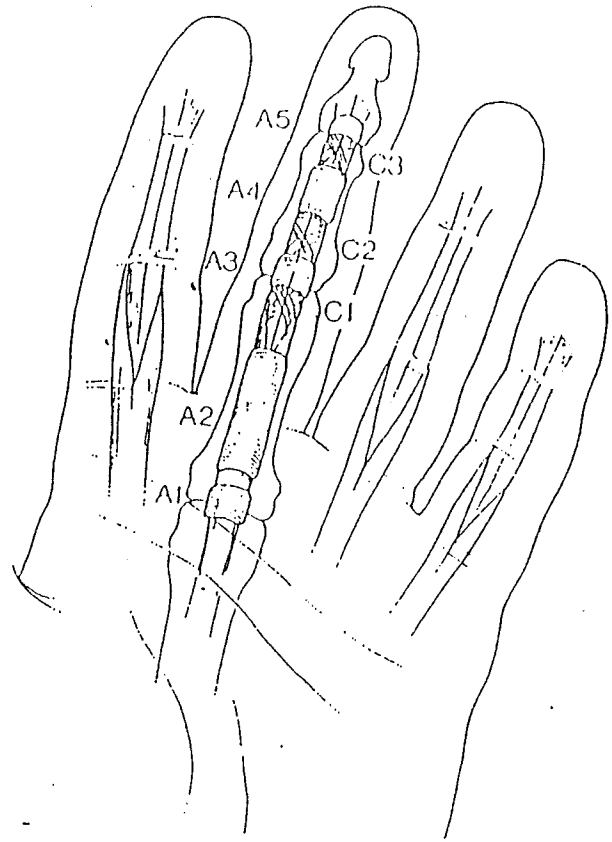

FIGURE 1b

The arrangement of the annular and cruciate pulleys of the flexor tendon sheath

Zone I

To thea Area running from the tips of all fingers to the region just proximal to the distal interphalangeal joints. It is this region the flexor digitorum profundus (FDP) tendons are inserted.

Zone 2

This is the area running from that portion of the fibro- osseous canal between the first annular pulley and the flexor digitorum superficialis insertion. Within this region the flexor digitorum superficialis and flexor digitorum profundus lie juxtaposed as they pass through the fibro-osseous canal separated from each other and the surrounding film of synovial fluid.

The fibrous portion of the canal has five (5) annular pulleys (figure 1b)

The arrangement of the annular and cruciate pulleys of the flexor tendon sheath. The first is at the MCP joint level. It attaches to the junction of the volar plate and the deep transverse intermetacarpal ligament. The second and third pulleys are at the mid portions of the proximal and middle phalanges. Between each annular pulley is a cruciform portion (cruciate pulley figure 1b) which is more flimsy, flexible and over lied each joint. The second and third pulleys are the most important elements of the pulley system. The five annular pulleys are known as A1, A2, A3, A4 and A5 while the cruciate pulleys are known as C1, C2 and C 3. This pulley system provides tensile and compressive force in zone 2 and 1.

Zone 3

Covers the region from the metacarpal joint of the thumb and the metacarpophalangeal joint of the four fingers to the distal end of the carpal tunnel in the palm.

Zone 4

Runs from the proximal end of Zone 3 to the proximal side of the wrist joint. It includes the carpal bones.

Zone 5

Runs from the proximal side of the wrist joint, to the mid point of the arm.

Tendon Healing

It has been shown by Ketchum[8] and others (1985) experimentally that tendon has intrinsic ability to heal even in the absence of blood supply. The cellular viability is maintained by adequate synovia fluid perfusion. There is however an inevitable extrinsic blood supply, due to cellular proliferation and fibrous tissue deposition which arises in the healing process in the surrounding tissue layers. All layers of the wound take part in the healing process and tend to envelop the healing tendon ends, tethering them to the surrounding tissues by dense adhesions.

The aim of surgical repair is intrinsic healing, with as few adhesions as possible. This requires non-traumatic treatment of the tendon, respecting the dorsally blood support and early hand motion (Brug[9]).

Technique of Tendon Suture

The main concern with tendon repairs will always be to get them moving, for an adherent tendon repair is a total failure. Over the years numerous suture techniques have been developed which seeks to obtain:

(a) A correct apposition of tendon ends after they have been trimmed.

(b) Sufficient resistance to traction on an organ whose fasciculated longitudinal structure does not hold sutures well.

All suture material represents a foreign body and increases the formation of granulation and scar tissue, a source of adhesions. Concerning the flexor tendon, Lindsay[10] (1960) and Potenza[11] (1975) have shown how trauma to a tendon can be dangerous and cause adhesions. Apart from the size of the thread, when tying on tendon fibres the bundles are caught in a knot and may become ischaemic then necrotic and hence the increase in scar formation (Ketchum[8] 1985).

For the flexor tendons it is extremely important to remember that a principal source of nutrition enters by the vincula which must be treated with great care by avoiding exteriorization of the tendons when it is not essential, and since the vessels run mostly along the dorsal surface, it is best to suture on the volar side of the tendon.

For the suture material the principal aims are:

(i) Use of the fine but strong material, which is physio-chemically inert and remains so in the tisues and does not provide scar reaction.

(ii) Adopt a suturing technique that respects the nutritional conditions, hence the repair of the tendon.

(iii) Try to bury the zone of suture in an undamaged sheath by appropriate modification of the digital position.

(iv) **Types of Suturing Material**

Great progress has been made in this area over the last 40 years. Bunnel[1] has shown the advantage of stainless steel wire, over cotton, linen, silk and other materials used at that time. Those wires cause minimal tissue trauma, but they should not be used where tendon change direction. Ultimately they fragment and provoke irritation.

Presently, synthetic materials, notably nylon are preferred as tissue tolerance has been shown to be comparable or superior to stainless steel (Ingari [12], 1997)

In hand surgery, gauges greater than 4-0, are rarely used while 6-0 is used for closure of epitenon, or small running sutures, allowing remarkably precise anastomoses without excessive trauma to the tendon ends.

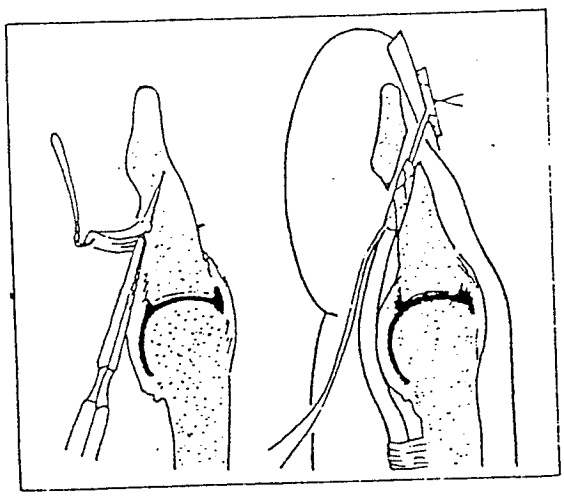

FIGURE 2

Intraosseous insertion into the distal phalanx by means of a stainless steel pull-out wire.

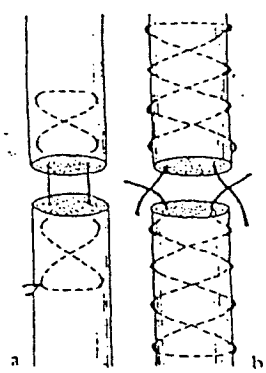

FIGURE 3

Shoe lace suture after Bunnel. (a) with one thread (b) with two threads, tied with a knot between tendons ends.

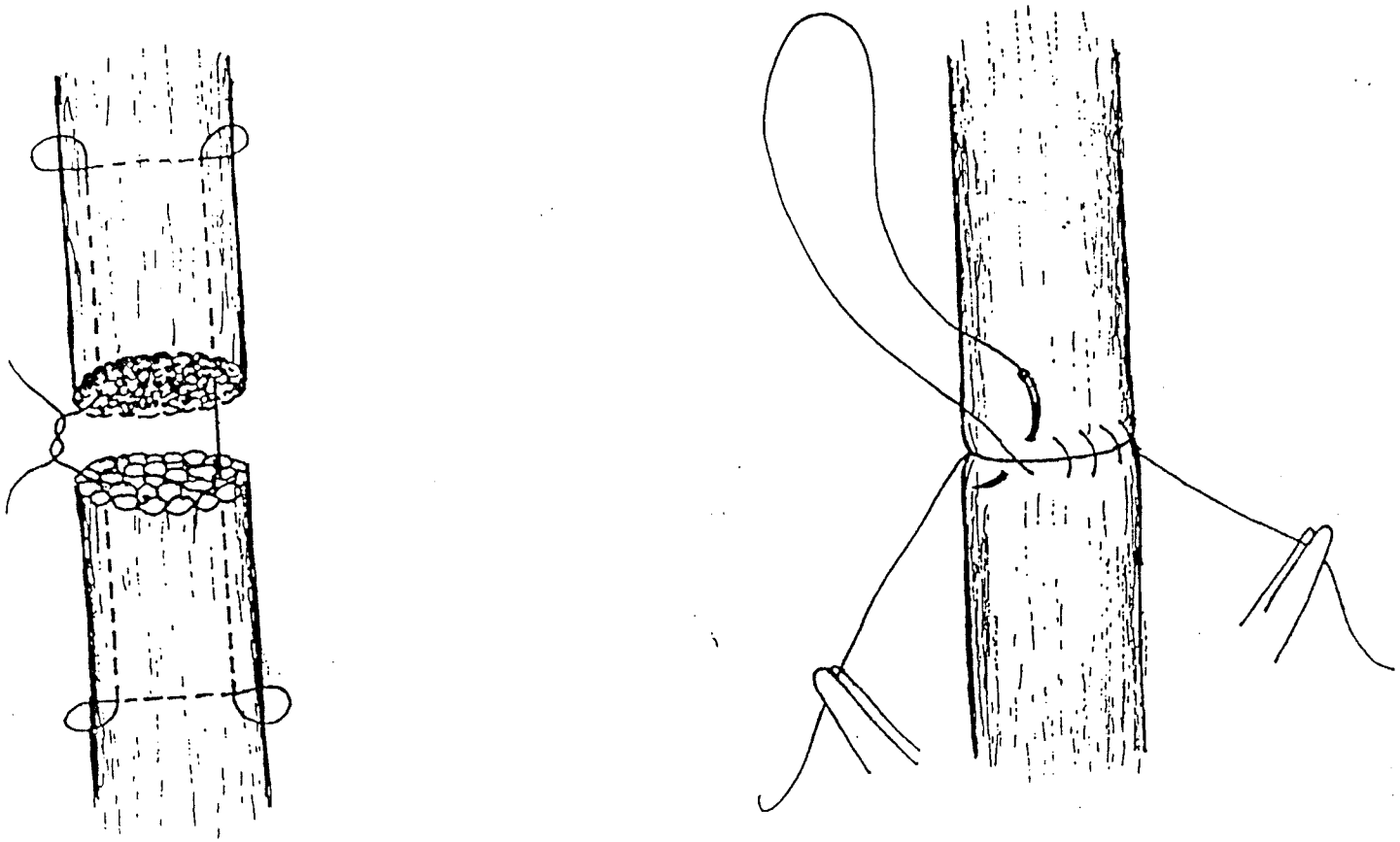

FIGURE 4

Tendon approximation using a core suture and a peripheral running suture (Kessler's method)

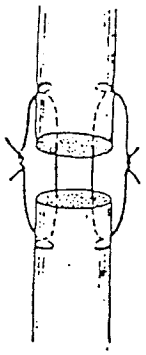

FIGURE 5

Two stitches firmly anchored around lateral fascicles after Wilms and Sievers.

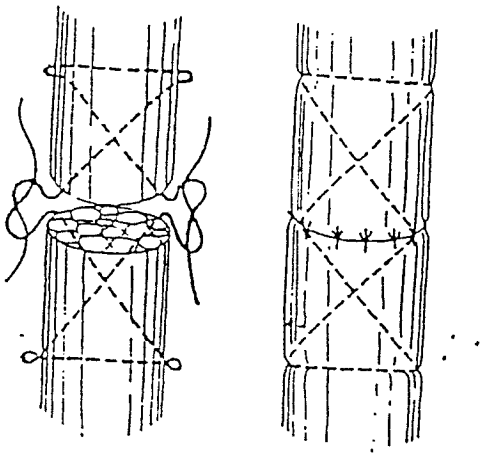

FIGURE 6

Simplified shoe-lace stitch with two threads knotted between the tendon edges (Koch and Mason).

Modes of Approximation of Separated Tendons

Lindsay and Potenza [8,9] (1979) have discussed this problem at length. It is not my intention to repeat the different techniques, but to note the most pertinent used.

a. In Zones 1,2 and 4 (Endosynovial region) that is the length of the digital canal of the fingers and thumb. Bunnels pullout technique (Fig 2) is used when the lesion is close to the distal extremity.

b. Zones 4 and 5 (Extrasynovial region and zones of rather free gliding) sutures illustrated in figure 3 (Bunnel), figure 4 (Kessler), figure 5 (Wilms and Sievers) and figure 6 (Koch and Mason).

(i) **Rehabilitation**

Just as the primary function of the muscle is to contract and then to relax, so the essential requirement of an intact tendon is to glide and so move the joint beyond which it is inserted. Adherent tendon repair is a total failure because active point movement is then impossible.

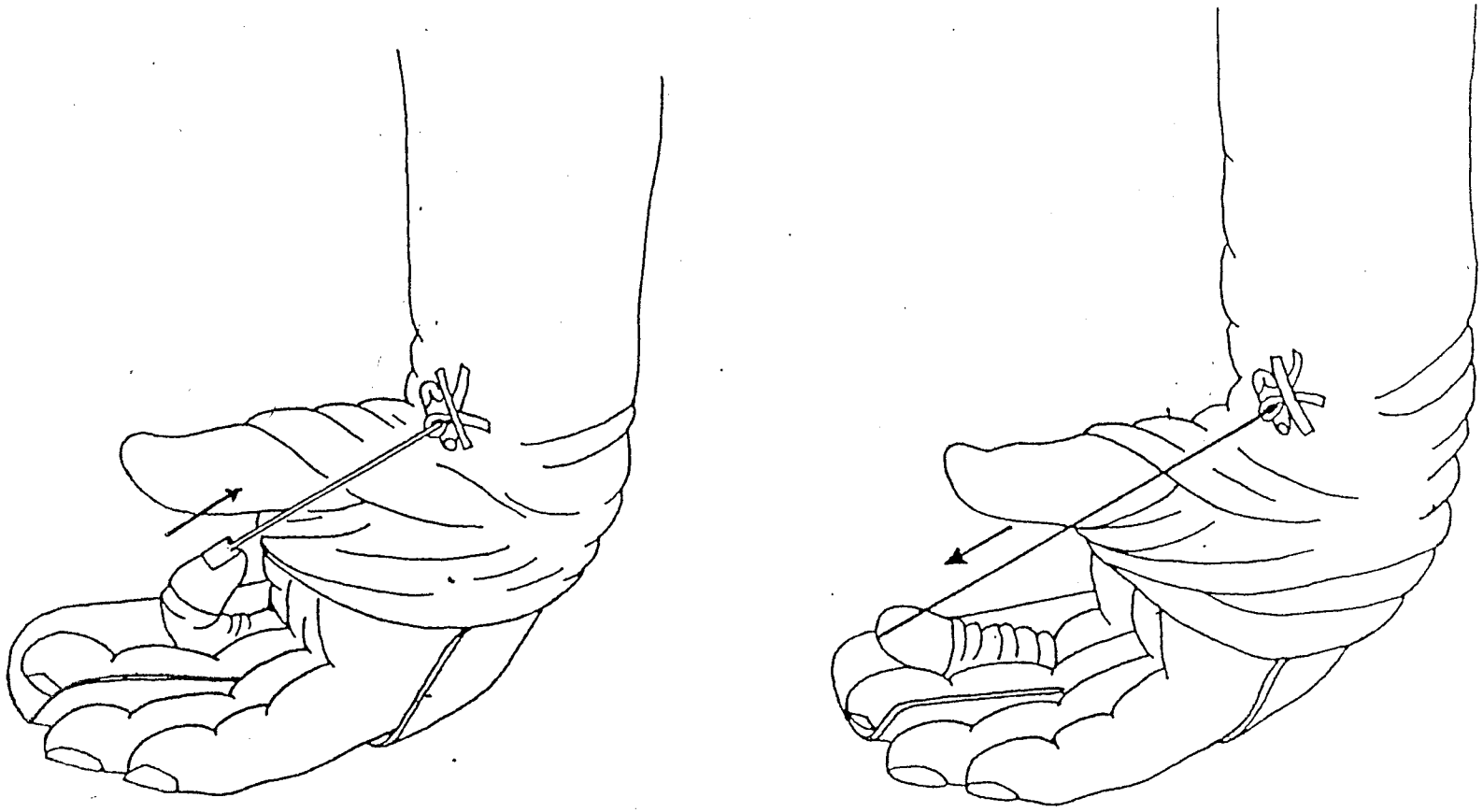

FIGURE 8

Kleinnert's method of post-operative immobilisation.

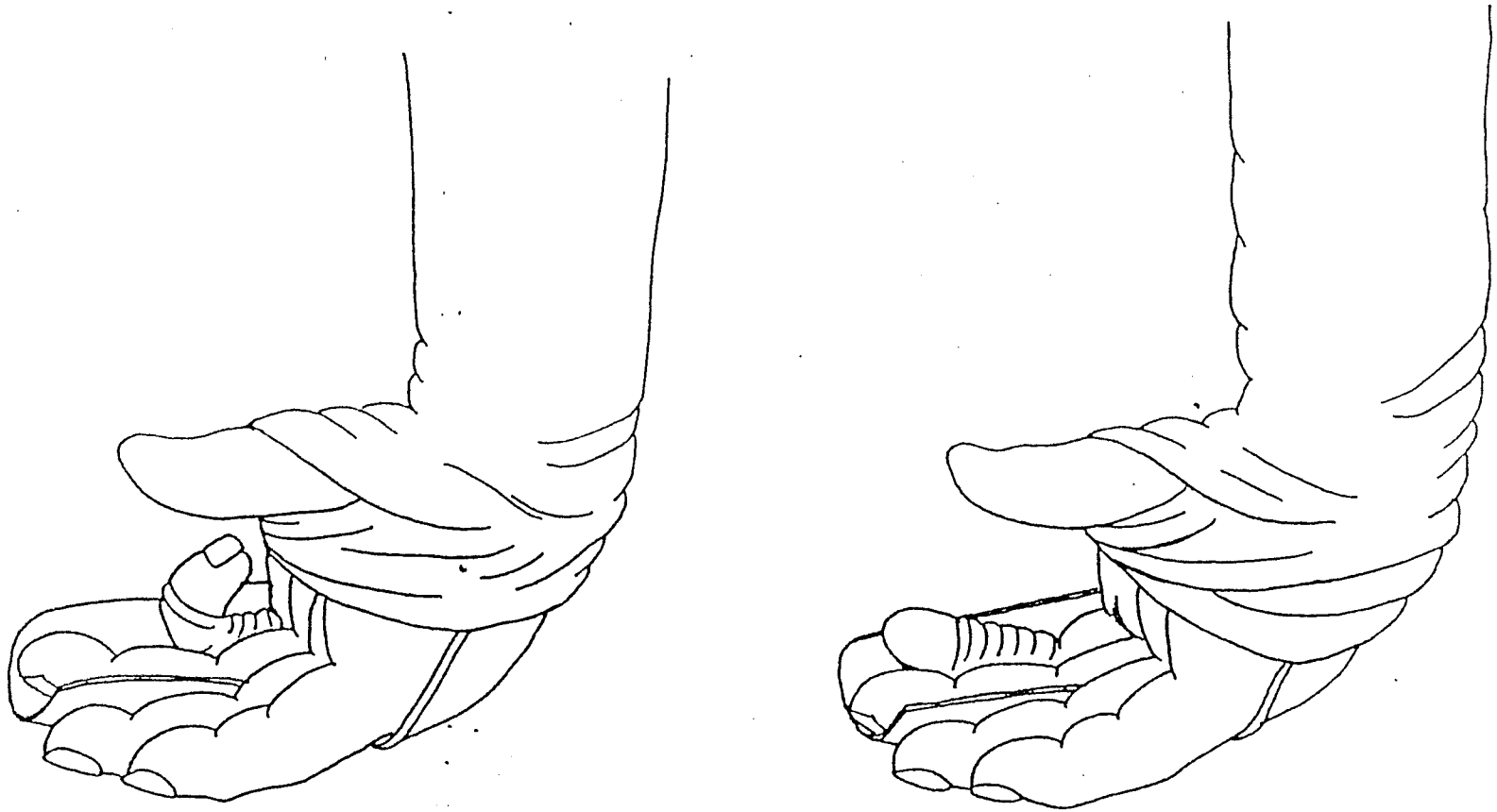

FIGURE 7

Duran's method of post-operative immobilisation.

(a) Duran's Method of Immobilisation

Over the years the dilemma has been how to maintain tendon integrity after repairs and avoid adhesions at the same time. Duran [13,14] (1975) demonstrated that post operative tendon management is geared to maximise intrinsic function by eliminating tension on the tendon by splinting the wrist in 20 to 25 degrees of flexion and metacarpophalangeal joints in 60 – 70 degrees of flexion. This came to be known as the Durans post operative immobilization (figure 7).

(b) Kleinert's Traction

Kleinert[7] in 1975 described a dorsal plaster splint constructed with the wrist flexed approximately 30 degrees short of full flexion and blocking full extension of the metacarpophalangeal and interphalangeal joints. The splint extends beyond the involved fingertips to the high forearm. A rubber band is placed on traction and a safety pin fastened proximal to the wrist and secured to hold position (figure 8). The dynamic rubber band traction applied to the fingernail holds the finger in flexion but permits active extension to zero degrees.

These two methods of post operative immobilization Duran[13,14] (1975) and Kleinert[7] (1975) have been found to be equally effective eliminating tension on the tendon and encouraging intrinsic healing. Although the postion of function has been used in the past to immobilize tendon repairs,

this increases tension on the repair needlessly (Ketchum[8], 1985). The main concern of tendon repairs will always be to get them moving.

To repair a tendon and not get in moving is as good as not repairing it (Ketchum[8] and others,1985).

MATERIALS AND METHODS

This prospective study was carried out on the Orthopaedic Unit of the Department of Surgery at the University Teaching Hospital, Lusaka between 1st January 1995 and 31st December 1997. Twenty patients were included. Informed consent was obtained prior to inclusion in the study. All patients were assessed with details of age, sex, occupation, injury, physical findings and location of injury recorded. (Appendix II).

We divided our management into 3 stages:

1. Pre-operative Assessment and Physiotherapy

This involved:

(a) Range of movements in the affected joints were measured and recorded using a hand goniometer. This assessment was carried out by a surgeon and the physiotherapist to allow proper planning for the surgical approach and technique.

(b) Skin preparation and passive joint exercises were carried out to achieve maximum range of passive movements and muscle power in order to facilitate surgical repair. Pre-operative physiotherapy was commenced on each patient immediately after inclusion in the study. Pre-operative physiotherapy lasted till a patient went for surgical repair. It averaged 20 days per patient.

2. Surgery

In this series, management of all flexor tendons of the hand was by secondary repair. Surgery was performed under General Anaesthaesia. Ten minutes before applying a tourniquet, each patient received 1-gram cloxacillin i.v. Tourniquet was then applied and time noted. The hand was cleaned with Iodine Solution and Spirit, then draped. Where tendon exposure was inadequate, extension of the wound using a volar zigzag or a dorsolateral incision in a digital direction was made to adequately expose the distal cut tendon. All questionably viable tissue and foreign material were debrided. Approximation of cut tendon was done using nylon 4/0 as a core suture and nylon 6/0 as a peripheral running suture (Kessler's Method) (Figure 4). Severed nerves were repaired with an epineural suture using nylon 4/0. For skin closure a 2/0 nylon was applied.

3. Post-operative Management

After closure of skin and removal of tourniquet a decision was made whether to use the Duran's immobilsation or Kleinert's Traction. Knowing that both methods have been shown to be equally effective Wang[15] (1996), decision on which splintage to use was made at random.

The dynamic rubber band traction applied to the affected finger nail (Kleinert's Traction), holds the finger in flexion but permits active extension to zero degrees. During finger extension the flexor muscles relaxes by

synergistic reaction. On attempted flexion the rubber band immediately flexes the finger, removes tension on the tendon and lessens the likelihood of rupture as the flexor muscle contracts.

At three weeks following the removal of the splintage each patient was subjected to a course of Hydrotherapy 10-15 minutes, active exercises, massaging of scar area and ultra sonography. This course was carried out weekly on each patient. At each physiotherapy session in the first 16 weeks assessments were done for the following: range of movement in all affected joints using a hand goniometer, sensation test using a pin and muscle power. Once the patient understood and appreciated the physiotherapy being carried out he was discharged then followed up on a weekly basis. Average stay in hospital was 14 days. After 9 months we evaluated our results using the Boyes and White combination [Appendix I].

Figure 9

RESULTS OF FLEXOR TENDON REPAIRS OF THE HAND

CASE	AGE/SEX	DATE OF INJURY	ZONE	TENDONS INJURED	NERVES INJURED	SIDE	PRIMARY MANAGEMENT	DATE OF REPAIRS	TENDONS REPAIRED	NERVES REPAIRED	POST OP. IMMOBILISATION	DATE OF FINAL ASSESSMENT	OUTCOME
1.	F/25	20.05.94	5	FDS – to index finger, ring finger, long finger and small finger FDP-index finger	Median	Right	Debridement and Suturing	12.6.94	All tendons repaired	Median	Kleinert	20.04.95	Good
2.	M/6	23.04.94	3	FDS – To index finger	Median	Left	Debridement and Suturing	12.5.95	FDS and FDP	Median	Kleinert	23.05.95	Fair
3.	F/3	18.9.95	2	FDS – To little finger and FDP to litter finger	None	Right	Debridement and Suturing	27.10.95	FDS (single tendon repairs) Palmaris longus used to reconstruct A_2 purkey	None		18.06.96	Fair
4.	F/23	04.05.95	5	FDS – To little finger and ring finger, FDP- To little finger and ring finger	Ulner Nerve	Right Hand	Debridement and Suturing	4.8.95	All Tendons Repaired	Ulnar nerve	Kleinert	05.02.96	Fair (contractures of ring and little finger)
5.	F/20	20.1.96	5	Flexor carpi-ulnaris, Palmaris longus, FDS-To long finger	Ulnar Nerve	Right Hand	Debridement and Suturing	09.2.96	All tendons repaired	Ulnar nerve	Duran	20.10.96	Excellent

Figure 9 (continued)

CASE	AGE/SEX	DATE OF INJURY	ZONE	TENDONS INJURED	NERVES INJURED	SIDE	PRIMARY MANAGEMENT	DATE OF REPAIRS	TENDONS REPAIRED	NERVES REPAIRED	POST OP. IMMOBILISATION	DATE OF FINAL ASSESSMENT	OUTCOME
6.	F/20	27.04.95	5	FDS – To index and long finger FDP – To index and long finger and Flexor Palmaris longus	Median	Left Hand	Debridement and Suturing Repair of flexor Palmaris longus; Median Nerve sutured to distal end of FDS to index. Repair of FDP – to index finger and long finger	15.06.95	FDS to index and long finger FDP to index and long finger as well as flexor palmaris longus	Median	Duran	27.05.96	Good
7.	F/40	16.1.95	5	Flexor carpi ulnaris FDS – Little and long finger FDS- To ring and long finger	Ulnar	Right	Debridement and Suturing	6.04.95	All Tendons	Ulnar Nerve	Duran	16.10.95	Poor
8.	F/20	04.06.95	5	Flexor carpi ulnaris FDS- To ring and little finger	Ulnar Nerve	Right	Debridement and Suturing	23.06.95	All Tendons	Ulnar Nerve	Kleinert	05.04.96	Excellent
9.	M/25	30.05.95	2	FDS – To index long and ring finger FDP – To index and long finger	Median nerve Branches to index and long finger	Right hand	Debridement and Suturing	05.10.95	All Tendons	Ulnar Nerve	Kleinert	01.06.96	Fair (late presentation)
10.	M/21	19.10.96	3/2	FDS- To long finger FDP – To long finger	Ulnar Nerve	Right	Debridement and Suturing	26.10.96	All Tendons	Ulnar Nerve	Kleinert	19.07.97	Fair (anticipated Zone 2 poor result)

CASE	AGE/SEX	DATE OF INJURY	ZONE	TENDONS INJURED	NERVES INJURED	SIDE	PRIMARY MANAGEMENT	DATE OF REPAIRS	TENDONS REPAIRED	NERVES REPAIRED	POST OP. IMMOBILISATION	DATE OF FINAL ASSESSMENT	OUTCOME
11.	35/F	02.03.94	2,3	FDS-Index, long FDP-Index, long	Median	Left	Debridement and Suturing	24.03.94	All tendons	Median	Kleinert	20.12.94	Poor
12.	30/M	12.01.94	5	Pamaris longus FDS-Index, small, long and ring FDP-Index, ring and small	Median and ulnar	Left	Debridement and suturing	26.01.94	All tendons	Median and ulnar	Kleinert	30.10.94	Good
13.	42/M	18.06.94	5	FDP-Index middle and ring FDS-to index, middle and flexor carpi - ulnaris	Ulnar and median	Left	Debridement and suturing of wound	12.12.94	All tendons	Ulnar and median	Duran	20.05.95	Good
14.	53/M	20.08.94	2	FDS-Index, ring FDS-Index ring	None	Left	Debridement and suturing	2.09.94	All tendons		Kleinert	20.05.95	Good
15.	46/F	15.03.94	2	FDS-Ring, index and long	Median	Right	Debridement and suturing	29.03.94	All tendons	Median nerve	Kleinert	20.12.94	Fair
16.	51/M	08.01.94	4	FDS-Long , finger	Ulnar	Left	Debridement and suturing	12.05.94	FDS-long finger	Ulnar nerve	Kleinert	09.10.94	Good
17.	19/F	06.06.94	2	FDS index	None	Right	Debridement and suturing	04.07.94	FDS index finger	None	Kleinert	07.03.95	Fair
18.	32/F	08.10.94	5	FDS-Ring, index long FDP-Long, ring	Left	Left	Debridement and suturing	10.13.94	All tendons	Ulnar	Duran	05.05.95	Good
19.	24/F	03.09.94	1	FDP-Index	None	Right	Debridement and suturing	30.09.94	FDP-to index	None	Duran	12.06.95	Excellent
20.	18/M	08.08.94	5	FDS-Index, ring long	None	Right	Debridement and suturing	28.08.94	All tendons		Duran	09.05.95	Excellent

ABBREVIATIONS

FDS	-	Flexor Digitorum Superficialis
FDP	-	Flexor Digitorum Profundus
F	-	Female
M	-	Male
POST-OP	-	Postoperation

TOTALS

1. Total number of tendons injured - 71
2. Total number of tendons repaired - 71
3. Total number of nerves injured - 17
4. Total number of nerves repaired - 17
5. Post-op immobilisaiton (a) Duran's – 06
   (b) Kleinert - 14

RESULTS

The just illustrated figure (figure 9) gives a graphic summary of the results. A total of 71 tendons were repaired in 12 female patients and 8 male patients, over the period understudy.

1. Causes of Tendon Injuries

Where:

(a) Domestic accidents with sharp objects 60%

(b) Industrial accidents 30%

(c) Animal bite 10%

2. Distribution of Tendon Injuries According to Zones

The illustrated figure below (figure 10) shows the distribution of tendon injuries according to zones.

Figure 10

Distribution of Zones

ZONE	NUMBER OF PATIENTS	PERCENTAGE
1	1	5.0
2	5	25.0
2/3	2	10.0
3	1	5.0
4	1	5.0
5	10	50.0
TOTAL	20	

3. Timing of Repair

Management of all tendon injuries was carried out by secondary repair. From the time of injury to the time to repair the periods ranged from 2 to 24 weeks.

This is the area where we faced most problems. All repairs were done as secondary repairs as it was practically impossible to carry out a primary repair.

4. Mode of Repair

The mode of repair was standardised. We used Kesslers Method. All repairs were carried out by one orthopaedic surgeon assisted by different Registrars.

5. Method of Post-operative Immobilisation/Physiotherapy

Figure 9 shows distribution of post-operative of immobilisation.

6. Associated Injuries – Nerve Injuries

Three patients had no associated nerve injury, seven had median nerve injury, ten had ulnar nerve injury and two had combined ulnar and median nerve injury. Figure 9 shows distribution of nerve injuries.

Ordinarily we repaired damaged nerves by an epineural continuos suture using a 4/0 Nylon; at the time of tendon repair. In cases where both nerves were severed we repaired both.

DISCUSSION

Despite the tremendous investigative efforts in the area of flexor tendon anatomy, biomechanics, nutrition, healing and adhesion formation, return to satisfactory digital performance following tendon interruption remains one of the most difficult and challenging problem for the hand surgeon. Although recent reports of improved digital performance after tendon repair, show considerable improvement to reports in the past, there can be no question that flexor tendon repairs in Zone 2 still represents a difficult and frustrating clinical problem.

The malevolence of the healing process in such that there is no treatment plan in tendon surgery that will guarantee a successful outcome. More than in any other area of the human body results will reflect the quality of each of the three stages of management: that is pre-operative management, surgical technique and rehabilitation.

1. Causes of Injuries

This study has shown that flexor tendon injuries are highest in domestic accidents with sharp objectives among housewives, second highest are industrial accidents among waiters and cooks and third highest animal bites among animal handlers (zoo employees).

The individuals identified who are at risk should be informed and warned of how damaging these injuries can be and protective measures be put in place to reduce the incident of these injuries.

(a) **Age and Sex**

The mean age of patients in this study was 26, oldest being 46 years and the youngest 6 years suggesting that our patients were mainly from the young generation. Of these, ⅔ were male. Four (4) of these males were waiters by profession whose livelihood depended on good functioning hands, only 2 went back to their full time jobs. This shows the importance needed to attach to this problem.

(b) **Zones**

Figure 10 shows distribution of zones affected. Zone 5 (50%) being the most affected followed by zone 2 (25%) then zones 3,4 and 1 each with 5%.

Results according to zones are as follows:

(i) Zone 5

From the 10 patients with zone 5 injuries; excellent results were in 3 patients, good 5, fair 1 and poor 1. This is the area expected to give the best results. At this level we are dealing with tendons whose sliding amplitude is considerable.

The less than satisfactory results we got in this Zone was attributed to the time lapse between injury and date of repair which in two (2) cases was between 12-24 weeks.

(ii) **Zone 4**

The only patient with zone 4 injury the result was graded as fair.

(iii) **Zone 3**

From 3 patients the results were as follows: 2 poor and 1 fair.

(iv) **Zone 2**

From 7 patients, the results were as follows: none of the patient was graded as excellent, 1 patient was graded as good and 5 as fair with 1 poor result.

Primary repair of flexor tendon injuries within this region has been one of the most difficulty problems in hand surgery. The poor results of tendon repair within the pulley area caused Bunnel (1947) to coin the phase "No Man's Land", Verdan subsequently described this region as Zone 2.

We carried out three (3) types of repair: repair of the superficialis with intact profundus (good result), repair of the profundus with intact superficialis, repair of both profundus and superficialis (fair) and we did one pulley reconstruction that is A_2 pulley reconstruction using palmaris longus, with a good result. As expected all digits with laceration and repair of the superficialis only had good to excellent. When both

superficialis and profundus were cut both tendons were repaired results ranged from fair to good.

When the profundus only was cut and we repaired it, results ranged from good to excellent (figure 9.)

(v) **Zone 1**

The only patient gave an excellent result.

Two patients had a combination of zone 2 and 3 injuries whose results were graded as 1 fair and 1 poor.

Finally at 12 months of follow up, 4 patients were graded as excellent, 7 good, 7 fair and 2 poor. Figure 9 shows distribution of results.

(c) Timing of Repair

All our repairs were carried out by secondary repair, as it was practically impossible for us to carry out a primary repair. Our aim was to do the repair between 2 and 4 weeks after the initial injury. However we had patients referred to us with up to 24 weeks from the time of injury. The best results were from those undergoing secondary repair within a maximum of four weeks after the time of injury.

The worst results were from those repaired after more than 4 weeks since the time of injury. We suggest tendon graft be considered for patients presenting with a history of more than 4 weeks from time of flexor tendon injury.

Even those who presented to us a few hours after injury had to wait up to 3 weeks for surgery due to one or a combination of the following reasons:

(i) Lack of theatre time

(ii) Lack of appropriate sutures or no sutures at all.

(iii) Lack of an experienced surgeon (currently if the University Teaching Hospital has only two specialists who can handle flexor tendon injuries).

(d) **Mode of Repair**

The specific techniques for tendon repair have varied considerably since the description by Brunnell in 1918.

All repairs carried out at the University Teaching Hospital were carried out using the 'Kesslers' types of stitch (first described by Kirchmayr in 1917), which is widely used in Hand Surgery is throughout the world. We found Nylon 4/0 and 6/0 sutures easy to handle and usually available at our Teaching Hospital. It seems that very few surgeons use 4/0 and 6/0 Nylon in their surgery at this hospital; hence its availability most of the time.

Inquiries around the pharmacies in Lusaka also revealed that 99% of the pharmacies in Lusaka stock Nylon 4/0 and 6/0 throughout the year. The Kessler's type is stitch is widely used in hand surgery centres throughout the world.

We ensured that all repairs in this study were carried out by the same Orthopaedic surgeon assisted by different postgraduate registrars. The

reason for this was two fold: to maintain objectivity in our study and to allow surgeons in training a chance learn how to carry out flexor tendon repairs.

(e) Method of Post-operative Immobilisation

Our study agrees with studies done elsewhere – there is no difference between the Kleinert and Durans Immobilisation as far as results are concerned. Most of our patients preferred to the Kleinert traction.

(f) Associated Injuries – Nerve Injuries

We repaired all nerve injuries with an epineural running stitch using 4/0 Nylon. The single conclusion made from this is that:

Damage to one digital nerve did not impair the result in that finger, but when both nerves were damaged, the result was compromised which is a common finding in all hand surgery centres throughout the world.

(g) Complications

Though no wound breakdown, infection or rupture of tendon at repair site was observed in this series, we did have two patients with poor results due to flexion contractures.

We attribute this poor result to the time taken to repair the tendons (up to 24 weeks from time of injury). We feel a tendon graft would have given better results.

As primary tendon repair at the University Teaching Hospital in ideal circumstance, ie within 6 hour of injury by the specialist, is practically impossible, any protocol that is developed has to take into account the constraints that we face.

These are:

1. Delayed referrals from the various provincial centres due to long distances and lack of transport.

2. Lack of optimum theatre facilities and theatre logistics once the patient arrives. It is logistically more satisfactory in most cases to have an appropriate theatre session available in each 24 hour period where such complex cases can be treated by an experienced surgeon.

3. A competent surgeon with training and experience in flexor tendon would make a difference, as these patients would not require secondary surgery.

4. Proper timing of the surgery would ensure optimum results. The ideal treatment programme is 'immediate surgery performed by an experienced surgeon'. If this were not possible then delayed primary surgery would be the next option. If delay exceeds 24 hours then the risk of infection will have reached a level which may prevent a satisfactory results.

5. Lack of trained physiotherapists with an understanding of the process of tendon healing in most centres inevitably results in disastrous results in spite of good repairs.

PROTOCOL FOR MANAGEMENT OF TENDONS INJURIES OF THE HAND AT THE UNIVERSITY TEACHING HOSPITAL.

1. If primary repair cannot be carried out, due to any of the already discussed reasons, a good surgical debridement of the wound, documentation of all injured tendons and classification of the injury according to "Verdan" should be done. The patient should then be referred to an Orthopaedic Unit for secondary repair.

2. Secondary repair to be carried out within a period of 2 to 4 weeks.

3. All patients awaiting definitive surgery for flexor tendon injuries (secondary repair) to be encouraged to undergo preoperative physiotherapy.

4. All surgery by an Orthopaedic surgeon for flexor tendon injuries be done with assistance of surgical registrars.

5. Patients presenting with flexor tendon injuries of a history of more than 4 weeks after injury are to undergo tendon graft surgery and not secondary repair.

6. Post-operative care should be carried out by the physiotherapy department till final assessment after 12 months.

CONCLUSION

The following conclusions were drawn from this study:

(i) As long as the current logistical problems with theatre and staffing continue, we have to rely on Delayed Primary Flexor tendon repair by an experienced surgeon, which is a universally accepted method of repairing tendons where primary flexor tendon repair cannot be carried out.

(ii) Even though best results are obtained if Flexor tendons are repaired primarily, in optimum conditions, they should not be treated as emergencies. If conditions and timing are not ideal, fresh wounds must be debrided and dressed and a clear record of operative findings made to facilitate subsequent surgery. However, these repairs must be carried out early on the next available theatre list rather than later.

(iii) Pre-operative physiotherapy is an important component of flexor tendon management. Poor results can be expected if proper planning is not carried out which will include, good skin preparation, good joint movement and full excursion of the intact tendons.

RECOMMENDATIONS

(i) A sound knowledge on the anatomy, biomechanics and physiotherapy of tendon repair is a pre-requisite to successful tendon repair. Meticulous attention to technical detail must be given during surgery. Failed primary repair is as good as no repair at all if not worse.

(ii) Supervised physiotherapy by an interested physiotherapist forms a major part in the success of flexor tendon repair whatever method of rehabilitation is used. Duran's and Kleinert's methods of treatment are both equally effective.

(iii) Even though the UTH physiotherapy department is capable of handling such patients, the attention to detail that such cases require, dictates that a particular physiotherapist with an understanding and interest in flexor tendon surgery must be involved for successful results.

(iv) Patient motivation has to be determined prior to the surgery and this may involve counselling and detailed explanation, which requires time. A desire to achieve good results will be an important prognostic factor.

APPENDIX I

Grading of Flexor Tendon results by White and Boyes:

Excellent: Flex within 1 cm of distal crease with less than 15 degrees loss of extension.

Good: Flex within 1.5 cm of distal palmar crease with less than 30 degrees of extension loss.

Fair: Flex within 2 to 3 cm of distal crease with more than 30 degrees loss of extension but less than 50 degrees.

Poor: Greater value of distance to distal palmar crease, or extension or both.

APPENDIX II

FLEXOR TENDON INJURY OF THE HAND SURGERY

Case No.....

HOSPITAL No.....

SURNAME: ..... FIRST NAME:.....

AGE:..... SEX:..... OCCUPATION: .....

PHYSICAL ADDRESS: .....

POSTAL ADDRESS: .....

NEXT OF KIN: .....

REFERING HOSPITAL: .....

ONSET/NATURE OF INJURY: .....

.....

SITE OF INJURY:

ZONES: I

II

III

IV

V

DETAILS OF INJURY

.....

.....

.....

OTHER INJURIES:

.....

.....

.....

.....

INVESTIGATIONS

DATE: ..... HB: .....

WBC: .....

LYM: ..... ESR: .....

OPERATION NOTES

NAME: .....

HOSPITAL No. .....

CLEAN/CONTAMINATED: ..... MINOR/MAJOR: .....

SURGEONS: .....

ANAESTHESIA: .....

PRE-OP PREP: ..... ANTIBIOTICS: .....

TOURNQUET TIME: .....

FINDINGS:.....

.....

.....

.....

.....

DETAILS OF SURGICAL REPAIRS:

.....

.....

.....

.....

.....

POST-OPERATIVE ORDERS:

.....

.....

.....

.....

PHYSIOTHERAPY REGIME:

NAME: .....

AGE: .....

FILE No. .....

POST – OPERATIVE OPERATION

(A) KLEINERT'S TRACTION

(B) DURAN'S CONTROLLED PASSIVE MOTION (STRICKLAND)

INITIAL FINDINGS AT SURGERY

TENDONS:.....

.....

.....

.....

.....

NERVES:.....

.....

.....

.....

REVIEW ASSESSMENT POST OPERATION

1. DATE:.....
2. DATE:.....
3. DATE:.....
4. DATE:.....
5. DATE:.....

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