

Radial Nerve Palsy

- R. SCHWARZ
J. JOSHUA
G. WARREN

INTRODUCTION

Radial nerve palsy is a serious functional impairment, causing loss of wrist, finger and thumb extension. The loss of wrist extension causes wrist instability and forces the fingers to flex at a mechanical disadvantage due to the finger flexors commencing action in a shortened position. This greatly reduces the strength in power grip. The loss of finger and thumb extension deprives the hand of the ability to grasp large objects. In leprosy, radial nerve palsy is often associated with median and/or ulnar palsy, which greatly compounds the impairment and limits the number of tendons available for transfer. The usual combination seen is a high radial palsy, a high ulnar palsy and a low median palsy. Many combinations of transfers have been developed for the treatment of radial nerve palsy.^{2,3,8,9,18,21,26,31} The actions that need to be restored are wrist extension, finger extension, and thumb extension-abduction. In triple nerve palsy thumb abduction and primary finger metacarpophalangeal flexion must be restored. The standard transfers that will be described in this chapter are shown in Table 8-2. While the standard transfers are very successful when performed correctly, Riordan correctly points out that "there is usually only one chance to obtain good restoration of function in such a paralyzed hand."²⁸ If the first procedure is not performed well, with excellent follow-up care, the chance of making a good functional hand is small.

The surgeon must have a good understanding of the three-dimensional anatomy of the

forearm and should review this prior to surgery. The principles of tendon transfer surgery as outlined in Chapter 1 must be followed carefully.

TABLE 8-1: List of abbreviations used in this chapter.

ECRB	Extensor carpi radialis brevis
ECRL	Extensor carpi radialis longus
ECU	Extensor carpi ulnaris
EDM	Extensor digiti minimi
EPL	Extensor pollicis longus
FCR	Flexor carpi radialis
FCU	Flexor carpi ulnaris
FDS	Flexor digitorum superficialis
PL	Palmaris longus
PT	Pronator teres

TABLE 8-2: Tendon transfer program for triple nerve palsy.

First Stage
PT to ECRB yoked to re-routed ECRL
FCR to EDC (and possible EPL)
PL to re-routed EPL
Second Stage
FDS (long) to lateral bands
FDS (ring) opponensplasty

The issues involving nerve repair, in case of trauma, will not be addressed here. The reader is referred to Green's discussion of this if desired.¹⁵ While some advocate early transfer as a splint to prevent contracture. I would suggest that the therapy team should be able to prevent such problems during the time of potential nerve recovery.^{7,22}

Pre-Operative Treatment

It is essential that the therapy team obtains and maintains joint mobility prior to tendon transfer and also to 'stretch' the long flexors out to full length. Thumb webspace contracture, if present, must also be corrected. Splinting is required, both to prevent contractures and to provide the mechanical advantage that wrist extension gives. Burkhalter notes that a simple cockup wrist splint can increase grip strength by three to five times.²³ More complex splints can be designed that provide dynamic extension of the thumb and fingers using outriggers with rubber bands that allow full flexion.¹² However these are very conspicuous and would probably only be used by those who will need to continue doing fine manual work prior to definitive surgery. Brand recommends that if only a cockup wrist splint is used then at night a splint that keeps the fingers also in extension should be used to prevent long flexor contractures.⁴

RECONSTRUCTION OF WRIST EXTENSION

There have been many modifications of the basic Pronator Teres (PT) to Extensor Carpi Radialis Brevis (ECRB) transfer since Jones first described the procedure in 1916.¹⁸ A few authors have advocated wrist arthrodesis.^{11,18} However the advantages of active wrist extension are so strong and the results of an active tendon transfer are generally so good that there is little reason to do a wrist arthrodesis as a primary procedure unless there are inadequate muscle-tendon units available for transfer. Brand has extensively studied the moment arms for the muscle tendon groups of the hand and has devised a procedure which is a modification of Jones' original procedure.⁴ We recommend this procedure as the most sound and most likely to function without complications.

Pronator Teres to Extensor Carpi Radialis Brevis Transfer

The ECRB has a strong moment arm for wrist extension but it also has a moment arm for radial deviation. Therefore a simple PT to ECRB transfer may lead to the development of radial deviation of the wrist, which wastes the PT movement in a non-useful direction of movement. FCU (if present) can resist this but this will weaken wrist extension. Three of fourteen patients undergoing PT to ECRB surgery in our series developed radial deviation adversely affecting function²¹, and 5 of 40 patients in Chotigavanich's series developed radial deviation.⁹ Some have also advocated yoking ECRB to ECRL.¹⁸ ECRL has a greater moment arm for radial deviation than wrist extension, thereby further aggravating the problem. Brand has shown well, when two tendons are yoked together, the one with the smaller moment arm will be preferentially activated by the transfer (Fig. 8-1).⁴ As ECRL has a shorter moment arm than ECRB for radial abduction, it will be the prime wrist mover, thereby pulling the hand into radial deviation following surgery. Brand tried yoking ECRB to ECU, but found that ECU had a small moment arm for wrist extension, and none when the wrist was pronated. He recommends yoking ECRB to ECRL, detaching ECRL from its insertion in the base of the second metacarpal and reinserting it into the base of the fourth metacarpal.⁴ This insertion has the same moment arm for extension as the ECRB, and will therefore give balanced extension. Tubiana describes a similar procedure using the same rationale.³¹ This transfer is the key to success of a rehabilitation program for someone with combined nerve palsies. Good wrist extension is necessary for effective finger flexion and will optimize the function of tendon grafts for intrinsic and opponens transfers. Interestingly, the muscle fibre excursion for the PT (25 mm) is only half that of the wrist extensors (59 mm). The fact that many patients undergoing PT

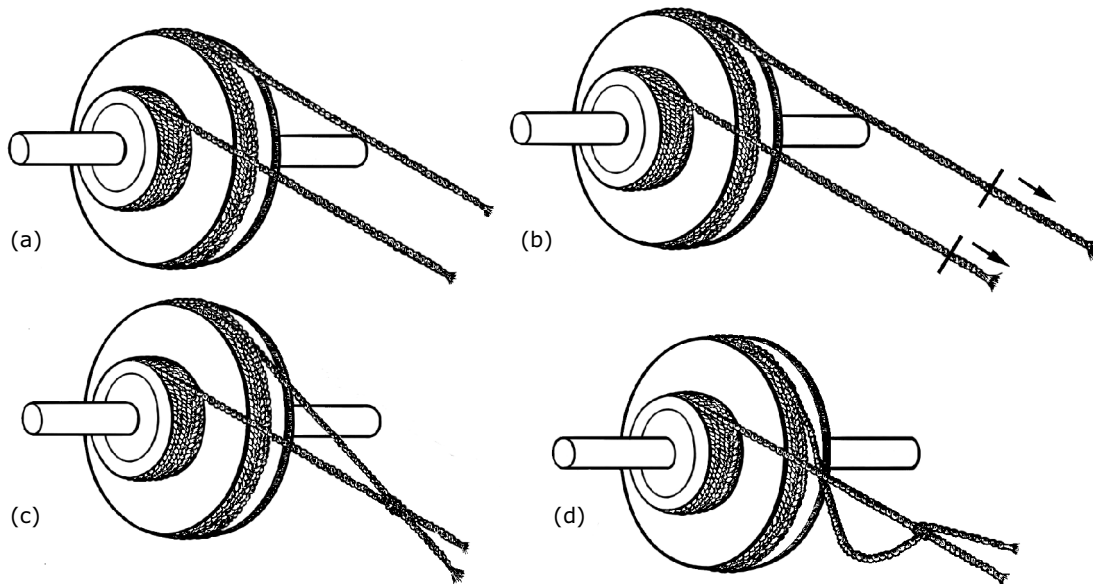


FIGURE 8-1 **a.** Two pulley wheels fixed to a common axle. **b.** For a given amount of rotation, the larger rope releases a longer length of rope (tendon) **c.** Both ropes are fixed together, similar to a double tendon insertion. **d.** Pulling on common rope (tendon) causes the rope on the wheel with the larger moment arm to become slack. Only the smaller wheel is functional (from Brand⁴, used with permission).

transfers for wrist extension eventually achieve a full range of motion implies that the excursion of the pronator muscle actually increases following surgery.²⁹ Brand suggests that sarcomeres are added or removed in response to a change in the tension of a muscle at rest, but that this process is slow.⁵

Technique: The PT to ECRB transfer is usually combined with the FCR- to-EDC (Flexor Carpi Radialis to Extensor Digitorum Communis) transfer. Only the incisions for the wrist extension part of the procedure will be described here (Fig.8-2). An 8-10 cm curved incision (1) is made over the convex part of the middle of the radial border of the forearm to expose the insertion of the PT and the tendons of ECRB and ECRL. At this level the ECRB tendon is usually surrounded by muscle but the tendon is easily found inside.

The insertion of PT is identified by following the muscle down to its fanlike insertion

onto the radius. The end is grasped and cut off the radius, taking care to include a 1-2 cm strip of periosteum with it to use for the anastomo-

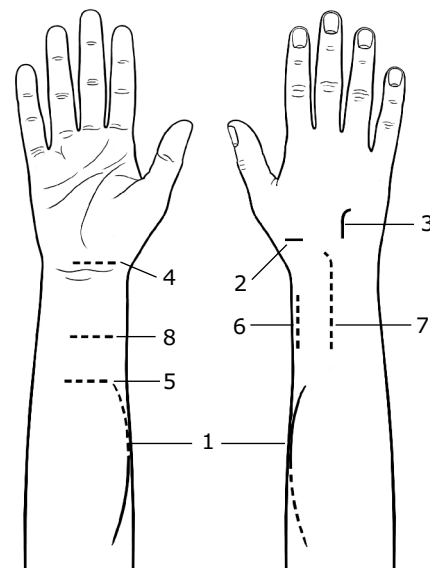


FIGURE 8-2 Incisions for PT to ECRB transfer (dark lines) and FCR to EDC transfer/ PL to EPL transfer (light lines). **a.** Volar aspect **b.** Dorsal aspect. Incisions are numbered as in text.

sis. It is easy to miss some of the upper attachments of PT to the radius. The PT is then brought around, superficial to the brachioradialis, to avoid adhesions to the radius (Fig. 8-3a). The wrist is put in a 45° extension splint. A small transverse incision (2) is then made over the insertion of ECRL, making sure it is not the extensor pollicis longus. The ECRL is detached and brought out through the proximal incision and then passed down superficial to deep fascia to a small incision (3) over the base of the fourth metacarpal (Fig. 8-3b). Attachments of

the ECRL to radius are freed to allow it to lie on the ulnar side of the ECRB. Here a distally based flap of periosteum is elevated and the end of the ECRL is fixed to periosteum with braided nylon suture. If finger and thumb extension transfers are being done in the same operation they are completed at this point.

The ECRB is then sutured side to side to the ECRL while applying equal tension on both tendons. The PT is passed through the joined ECRB/ECRL tendon as far distally as possible and sutured with braided nylon with moderate (1 cm) tension. The end is buried in the muscle and the anastomosis is covered with 6-0 monofilament nylon. The skin incisions are then closed. The wrist is immobilized in 45 degrees of extension for four weeks before mobilization is commenced (see Chapter 21 for specific therapy techniques).

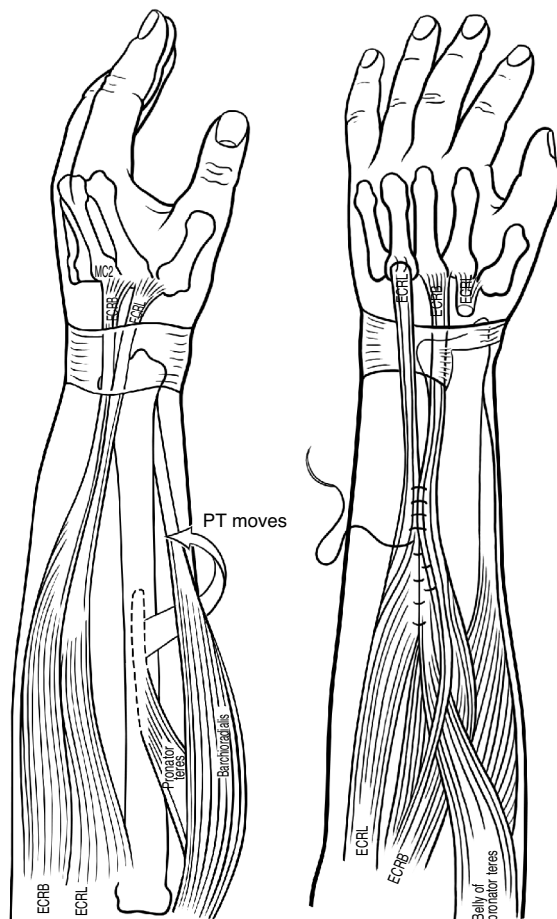


FIGURE 8-3 a. The PT is elevated with a strip of periosteum and transferred above the brachioradialis. **b.** ECRL is transferred to base of the ring metacarpal, ECRL is attached to ECRB and the PT is attached to ECRB (from Warren³³, used with permission).

RECONSTRUCTION OF FINGER/THUMB EXTENSION

Thumb extension

Brand advocates the use of the palmaris longus (PL), when available, as the active tendon, to replace the extensor pollicis longus (EPL).⁴ In the absence of the PL, the FCR is the tendon of his choice. The replacement of the abductor pollicis longus (APL) is also stressed by Brand, as it acts as an extensor of the metacarpal of the thumb, providing for a “circle” pinch. To achieve this, the preferred active muscle is the FCR. However in these instances, Brand is considering the radial paralysis alone with normally functioning intrinsic muscles.

However in cases of leprosy, we normally encounter a triple nerve paralysis, where the adductor pollicis and other intrinsic muscles of the hand are paralysed and consequently, the muscle imbalance is different. Moreover the number of active muscles available for the transfer is limited.

Finger Extension

Many active muscles have been used in the replacement of finger extensors. Jones advocated the use of the FCU¹⁸, while Brand has used the FCR for four-finger extension.^{3,4} Clezy,¹¹ and later Fritsch,¹³ have advocated the use of the FCR for the restoration of four-finger and thumb extension. Goldner and Kelly¹⁴ and later Boyes² and Chuinard,⁸ have recommended the use of the FDS muscles of the ring and/or middle fingers for finger extension. However this is acceptable only if the radial nerve is the only paralysed nerve. If there is associated ulnar and median nerve palsy (triple nerve palsy), as is usually the case in leprosy, these tendons are needed for intrinsic muscle replacements.

Advantages and disadvantages of various procedures

The PL, if present, is an ideal muscle to use for thumb extension. The EPL tendon may be re-routed more radially to be attached to the PL to improve the direction of action.

The FCU as the extensor of the fingers has the advantage of being strong and well able to provide the necessary action. However, it lacks the excursion required to provide a complete range of motion. (Its ulnar side fibres are only 4 cms long). It is also too bulky and causes an unsightly bulge as it crosses over on the ulnar border of the wrist from the flexor to the extensor aspect. It is an important muscle in its own right, causing essential ulnar deviation in activities like hammering and cutting vegetables. Use of this muscle for the transfer deprives the wrist and hand of these effective actions.

The FCR has the advantage of having greater excursion than the FCU and therefore can cross more than one joint. It is also less bulky and therefore is not as unsightly on transfer. It has the disadvantage of having the scar of all tendon junctions at the region of the extensor retinaculum. This can cause problems with mobilization in the post-operative period due to adhesions.

The FDS muscles to the ring and middle fingers have the advantages of good length so that the tendon sutures lie well distal to the retinaculum reducing the risk of adhesions. The FDS has adequate excursion to allow full range and independent movement of the wrist and fingers. The relative disadvantage is that the FDS are antagonists to the movement they are required to produce making re-education more difficult.

This transfer is usually done in combination with the previously described procedure for extension of the wrist; that is, in the same sitting it will follow Pronator Teres transfer to the ECRB.

Palmaris Longus to Extensor Pollicis Longus and Flexor Carpi Radialis to Extensor Digitorum Communis Transfer

Indication: Radial nerve paralysis in isolation or in combination with a high ulnar and low median paralysis.

Technique: Following the PT to ECRB transfer, a small incision (4) (Fig. 8-2) is made over the wrist crease over the visible PL tendon. The tendon is identified, isolated and withdrawn in the forearm via incision 5, about 10 cms proximally. Through a longitudinal incision (7) just proximal to Lister's tubercle over the level of the extensor retinaculum, the EPL is identified and isolated. It is divided at its musculo-tendinous junction. This tendon is withdrawn distally, just proximal to the metacarpophalangeal joint of the thumb. It is tunneled subcutaneously to lie over the tendon of the APL. The PL tendon is then tunneled subcutaneously to meet the EPL at this point, incision 6. It will lie basically in line with the first metacarpal. The two tendons are sutured here with a short interlace, under high tension, with the thumb positioned in extension in the same plane as the palm (Fig. 8-4).

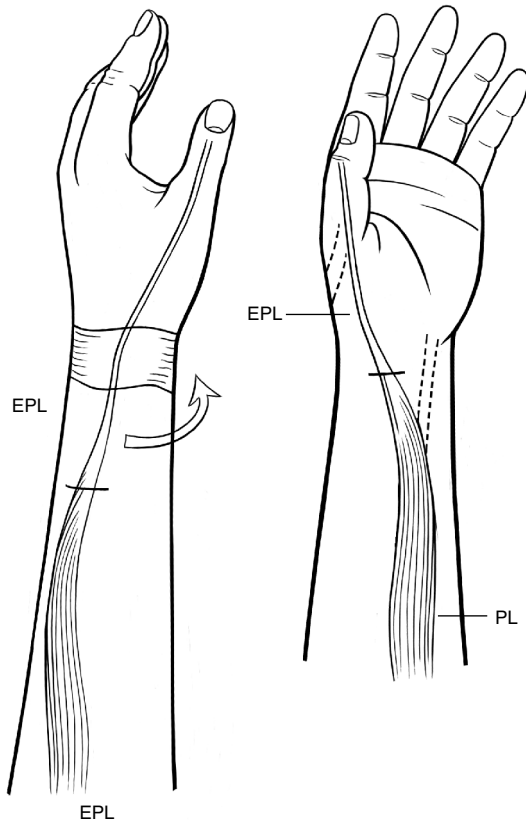


FIGURE 8-4 Route of PL to EPL transfer. Moving the EPL tendon to the radial side of the wrist will produce both abduction and extension.

Through the same incision over the wrist crease, just proximal to the insertion of the FCR, the tendon is isolated and detached from its insertion and recovered in the forearm through a transverse incision (8) about 7 cm proximally. A longitudinal incision (7) is made on the midpoint of the dorsum of the wrist and the extensor retinaculum is cut along the same line to expose the EDC. The FCR is tunneled subcutaneously into this incision, finding the path of least resistance using a blunt instrument.⁴ Setting the tension correctly is difficult, especially in triple nerve palsy. With the wrist in about 45 degrees extension, and the fingers extended fully at the metacarpophalangeal joints, the FCR tendon is passed through the

individual slips of the extensor digitorum as distally as possible after taking up the slack. It is sutured in such a manner as to incorporate all the tendons in the stitch (Fig. 8-5). Another method is to insert the FCR into the extensor tendons of the ring and middle fingers and then to attach the tendon of the index to that of the middle and the tendon of the little finger to that of the ring finger. Most authors do not include the EDM for fear of creating too much extension/abduction in the little finger.¹ Green suggests pulling on the EDC to assess the adequacy of little finger extension.¹⁵ If there is an extensor lag of the little finger, the EDM is also included in the transfer.

The transfer should then be tested passively. Wrist flexion should produce MCP joint extension but not hyperextension. With the wrist extended it should be possible to achieve full

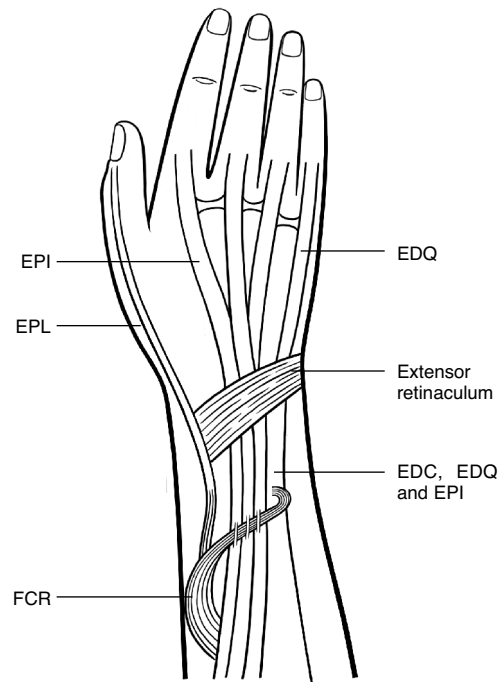


FIGURE 8-5 FCR to EDC transfer. A single weave is carried out obliquely, and the unsatisfied end is buried in one of the extensor tendons. A similar join is carried out for an FDS transfer but comes either through the interosseous membrane around the ulnar border.

finger flexion. The tourniquet is now released, haemostasis achieved and the wounds closed.

In case the PL is absent, Brand advises the use of one of the FDS tendons for extension of the thumb.³ This however can be done only if the paralysis is confined to the radial nerve, as the FDS tendons will be needed for intrinsic replacement procedures in a triple nerve palsy. Frittschi,¹⁴ and McEvitt and Schwarz²¹ however, advocate the use of the FCR divided in two slips, one for thumb extension and the other for four-finger extension even when the palmaris longus is present. The EPL can be taken out of the dorsal retinaculum as shown in Fig. 8-5 to give more abduction. They advise leaving the palmaris longus in situ as a flexor of the wrist.

Multiple Flexor Digitorum Superficialis to Extensor Pollicis Longus and Extensor Digitorum Communis Transfer

Indication: Isolated radial nerve paralysis

Technique: The FDS of the ring finger and/or middle finger are detached from their insertions through incisions in the respective fingers and recovered in the mid forearm. Here they are tunneled through a window in the interosseous membrane passing on either side of the flexor tendon mass. The tendons are received in the dorsum and then tunneled subcutaneously to the dorsum of the wrist. The extensor retinaculum is opened. The EDC tendons and the EPL are identified. The middle finger superficialis is attached to the EDC and that of the ring finger is attached to the EPL. The postoperative immobilization regime is the same as that described for the FCR and PL transfers (see below), although specific therapy techniques will obviously differ.

When the PL is available for the thumb, the FDS of the middle finger alone can be used for the four fingers.

Post-operatively: Place the arm in a full plaster from the fingertips to the upper arm, with the forearm fully pronated and the elbow at 90°. The wrist is kept at 45° of extension with the fingers kept fully extended. The plaster is bivalved at three weeks and cut off below the elbow. Gentle range of motion and transfer activation exercises are commenced. By seven weeks post-op a full unrestricted range of motion should be achieved (see Chapter 21). Physiotherapy should be continued until adequate wrist extension is achieved. Schreuders et al demonstrated continued improvement in active range of movement following a PT to ECRB transfer up to one year following the surgery.²⁴ This is probably because therapy not only trains the patient to effectively use the transfer, but also trains the muscle to increase its excursion as noted above. It appears to take some time for a muscle to increase its excursion.

Wrist Arthrodesis: Arthrodesis of the wrist should be reserved as a last option, as loss of movement of the wrist adversely affects the functioning of the hand. Even with a triple palsy with a high median nerve involvement, a more functional hand can be obtained with the 'hinge hand' operation (see below) than with an arthrodesis. Weiss et al³³ report that efficiency of hand function decreases by only about 20% following wrist fusion, but it should be noted that these were patients with normal neurologic status. Patients with multiple nerve paralysis would be expected to have a greater negative impact on hand function from wrist arthrodesis.

Indications:

1. Wrist instability, subluxation or neuropathic degeneration.
2. Failed PT to ECRB transfer without hope of successful revision.
3. Triple nerve palsy with high median involvement (relative).

There are now several methods of internal fixation available, which can be used if the equipment is obtainable. Arbeitsgemeinschaft Osteosynthesefragen (AO) techniques of plating have reported non-union rates of 0-2%.^{17,33} The following method requires only K-wire fixation, is easy to perform and has a very high success rate.¹³ If tendon transfers are planned in the same hand, the arthrodesis should be carried out before the transfer to avoid disuse and further adhesions of the transfer. The ideal position of wrist fusion has not been determined. In one study common activities of daily living were found to use an arc between 10 degrees of flexion and 35 degrees of extension.⁶ Most authors recommend a position of about 10 degrees of extension.¹⁶ Pryce²⁵ reported that power grip was greatest in slight extension and ulnar deviation, and Kraft and Detels¹⁹ found that grip strength was similar from 0-30 degrees of extension but was weakened in flexion. It would seem that a position of between 0 and 10 degrees would be ideal.

Technique: A lazy S incision is made from the base of the third metacarpal to a point 7 cm proximal to the tip of the radial styloid in the center point of the dorsal forearm. The skin is mobilized at the level of the deep fascia, preserving as many of the veins as possible. The deep fascia and retinaculum are then raised as an ulnar-based flap along the full length of the incision. This can be difficult to keep as one piece, especially over the distal radius. The extensor tendons are now exposed. The extensor digitorum tendons are retracted ulnarwards and the extensor pollicis longus tendon radially. The periosteum is then stripped off of the radius. A strip of bone graft is harvested from the distal end of radius by cutting a groove 5 cm long, 5 mm deep and 6 mm wide, tapering distally. An oscillating or circular saw is best for this, although I (RS) usually use osteotomes. The joint spaces of the

radioscaphoid, radiolunate, capitulunate joints are opened and the articular cartilage of each joint surface is removed with bone nibblers, saw or a gouge. Some also include the third CMC joint.

With the wrist held in 30° extension, the groove in the radius is extended through the lunate and scaphoid using a gouge or fine nibblers. This groove is then continued directly into the head of the capitate, gouging a hole with a gouge or a drill with the wrist in flexion (Fig. 8-6). This extends up into the base of the third metacarpal and must be wide enough to fit the bone graft. The distal end of the bone graft is then gently hammered into the hole, after which the wrist is slowly extended until the graft fits back into the groove. Cross K-wires are used to stabilize the wrist. Any remaining cancellous bone is used as bone graft. The periosteum is then sutured over the graft and the fascial flap sutured over the tendons and skin closed.

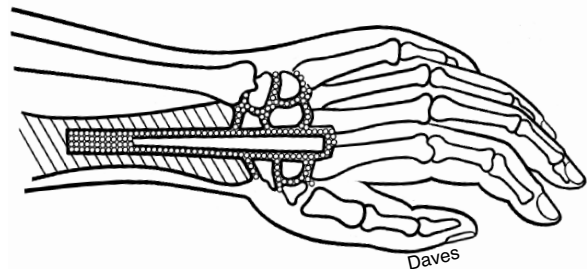


FIGURE 8-6 Wrist arthrodesis. The bone graft is harvested from the distal dorsal radius and placed in the carpus and inserted into the base of the third metacarpal after creation of a groove through the lunate, scaphoid and capitate.

A plaster extending from the PIP joints to above the elbow is placed for 10 weeks total. A check X-ray must be taken prior to plaster removal. The plaster can be trimmed to allow finger movement at four weeks. If not buried the K-wires should be removed at one month.

The finger and thumb extension procedures can be carried out when there are 3 weeks remaining until plaster removal.

Complications: Infections and skin edge necrosis are unusual. The most common, and serious, complication is delayed or non-union. The rate of non-union has been reported at 5-18% using techniques not utilizing plates.^{10,16} AO plate methods of fusion however have reported non-fusion rates of 0-2%.¹⁶ Adhesions of extensor tendons can occur. Carpal tunnel syndrome has been reported in 4-10% of arthrodeses using the AO plate fixation.¹⁶

COMBINED NERVE PALSIES

As mentioned, in leprosy radial nerve palsy is usually seen in combination with median and/or ulnar palsies. Combined nerve palsies may be seen in other peripheral neuropathies as well. A complete hand assessment is mandatory to determine which muscles are still available for transfer. In the presence of a low median/high ulnar palsy, the most usual presentation, the usual plan is a two or three stage reconstruction to carry out the procedures outlined in Table 8-2. In the first stage the wrist and finger/thumb extension replacement procedures are performed. There is concern that removing the PL would leave the wrist without a dedicated flexor. Zachary has demonstrated that the PL alone is not adequate to provide wrist flexion in a hand with a simple radial nerve palsy.³⁴ While it appears to be adequate in a triple nerve palsy hand, removing it will leave the wrist without an independent flexor. For this reason we usually use FCR to activate extension in both fingers and thumb. However the finger flexors will also stabilize the wrist in flexion. Therefore if independent thumb extension is needed the PL could be used in this situation. In the second stage a sublimus transfer (FDS to lateral bands, see Chapter 6) is carried out for intrinsic replacement, and an opponens replacement is performed using flexor digitorum superficialis (Chapter 7). It is important to

avoid making the sublimus replacement so tight that the finger extensor transfer is unable to extend the metacarpophalangeal joints.¹ It is best to do a Bunnell type transfer to the lateral bands as opposed to the flexor pulleys, as with the latter the finger extensors have to extend the interphalangeal joints on their own. Arthrodesis of the thumb metacarpophalangeal joint or a half flexor pollicis longus transfer would be appropriate for stabilizing the thumb (Chapter 6).

It should be noted that not all patients with a triple nerve palsy will be candidates for all procedures. In our study 18 of 21 patients undergoing reconstructive surgery for radial nerve palsy secondary to leprosy reactions had involvement of all three nerves.²¹ Of these 18, only eight had intrinsic reconstruction and ten had opponens reconstruction. Reasons for this were partial nerve palsy, refusal of further surgery, or unsuitability for further reconstruction. Some patients presented with severe contractures or shortened digits and were not considered candidates for reconstruction of all functions.

In combined low median and high radial nerve palsy with an intact ulnar nerve, an FCR to EDC transfer should be carried out. The FCU will maintain wrist flexion. The PL should then be used with a re-routed EPL to provide thumb extension and abduction. This procedure may provide enough abduction that the patient may not desire to proceed with an opponensplasty. Combined high median and radial nerve palsy with intact ulnar nerve is virtually never seen in leprosy. If it does present, Omer recommends wrist arthrodesis, or PT to ECRB transfer if available, for wrist extension with the FCU transferred to EDC and EPL for finger/thumb extension.^{22,23} A tenodesis of FDP tendons of the index and middle finger to FDP of ring and little fingers is carried out to give active finger flexion of all fingers. The

thumb is stabilized by thumb MCP arthrodesis, tenodesis of FPL across the IP joint and tenodesis of the APL tendon to the radius.

If the median nerve is intact with a combined radial/ulnar palsy then a Bunnell type sublimus transfer is carried out as second stage procedure. Again, arthrodesis of the thumb metacarpophalangeal joint or a half flexor pollicis longus transfer would be appropriate for stabilizing the thumb.

The hinge hand procedure

It is not uncommon to be requested to reactivate a hand in which there are very few muscles functioning. The patient desires appearance, social acceptability and as much function as possible. There are many options aimed at providing the maximum possible function and appearance. Transfers for tetraplegic patients are described elsewhere.¹⁶ However there is a relatively simple procedure that often gives a satisfactory result in the severely motor deficient hand.

If there is only one muscle of reasonable strength that can be used in isolation, it can be used to activate wrist extension to provide a "hinge hand". The hand at rest should be in a normal posture and when the wrist is extended the fingers close for grasp. Patients do not have a lot of strength but there is usually enough stability to hold large light objects especially if they have a stem for easy holding. If this muscle can be used to provide a good wrist extension it is possible by tenodesis of the flexors to provide a hand that grasps, albeit weakly.

A normal strength ECRB or ECRL is usually adequate although the wrist extension may be stabilised by yoking one tendon to the 4th metacarpal base to give pure wrist extension. No other active transfer will be needed. If there is no active wrist extensor it is necessary to transfer some other muscle, yoked to give better wrist extension stability. Suitable muscles need to be relatively strong and they

include brachioradialis, pronator teres, flexor carpi radialis and FDS.

It is desirable to tenodesise any extensor tendons at the same time as the active transfer is inserted. This allows a uniform tension to be achieved across all extensors. The technique described is similar to that of Zancolli.³⁵ The flexor tendons are tenodesised 3 months or longer before the extensors are dealt with so that they can be put in more tightly than would be possible if extensors were done first. A tenodesis of thumb opposition can also be performed, usually at the time of the flexor tenodesis. This will alter the ability to grasp objects of wide diameter but will improve the ability to hold something like a drinking glass with a narrow stem as the rim of the glass will be supported all around. Alternately, the abductor and long flexor of the thumb can be tenodesised.

Technique-flexors: Initially the flexor side is operated on. The FDS tendons are located about 2-3 cm above the wrist on the radial side of the forearm, and sutured together, side by side, when the fingers are straight. For attachment to the radius, use a small 2-3 mm diameter drill or burr and drill a series of 3 small holes, the distal two being 0.5 cm apart and the third one some 1 cm proximal. The bridge of bone between these two distal holes is removed so a cavity down to the marrow is displayed (Fig. 8-7). The flexor tendons are identi-

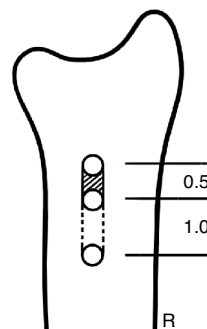


FIGURE 8-7 Tenodesis technique. Three holes are drilled in the distal radius. Then the bone between the distal two holes is nibbled to create a larger single hole. A sub-cortical tunnel is then created between these two holes through which a single tendon will then be passed.

fied and pulled tight with the fingers extended, and wrist straight or up to 10 degrees flexion. They are sutured together at the site of the distal hole. The long finger tendon is then cut and passed into the distal hole and out through the proximal hole. A strong Silk or braided nylon is used to pass this tendon into the distal cavity and out through the proximal hole so the ten-

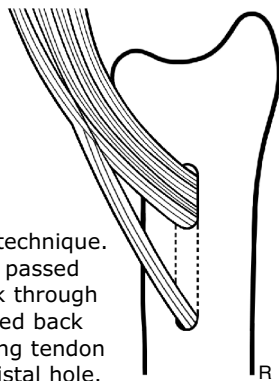


FIGURE 8-8 Tenodesis technique. A single flexor tendon is passed from the distal hole back through the proximal to be sutured back to itself and the remaining tendon ends are buried in the distal hole.

don can be sutured back to itself, (Fig. 8-8). This means that only 3-4 weeks immobilisation is required for enough healing to start physiotherapy. If the tendon is inserted in bone via a Bunnell suture so that the tendon just ends in the bone a much longer immobilisation is required. This tenodesis ought to result in the fingers being flexed at the MCP and PIP joints when the wrist is extended (Fig. 8-9). The degree of flexion will depend on the position of

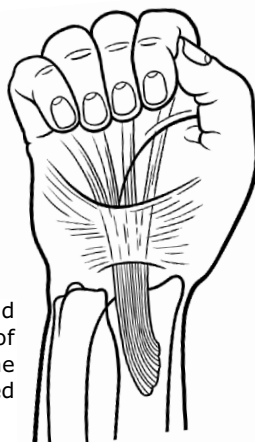


FIGURE 8-9 Hinge hand procedure. Extension of wrist produces flexion of the fingers (from Warren³³, used with permission).

the wrist when the tendon length is cut before suturing.

The long extensor of the thumb can be attached similarly but it is often better to divide EPL and attach it to the insertion of FCR so that the thumb automatically pulls out straight and into abduction when the wrist extends. This should be done at the same time as the flexor tendon tenodesis. McDowell and House recommend stabilizing the thumb by carpometacarpal joint fusion, combined with a half flexor pollicus longus to extensor pollicus longus transfer to stabilize the interphalangeal joint.²⁰ After this procedure the arm is plastered with the wrist flexed, the fingers straight and the thumb fully opposed and abducted.

Technique-extensor: The methodology for transferring the basic active motor (PT or if absent brachioradialis) into ECRB is as described above.

For the finger extensors it is necessary to open the forearm for about 5 cm proximal to the wrist with an incision that allows dissection onto the ulna bone about 2-3 cm proximal to the wrist joint, where the tendons will be attached. The attachment technique is the same as for the FDS (Fig. 8-10). The tension for this suture is fixed at neutral when the fingers are straight and wrist extended about 10-15 degrees. This should allow the fingers to straighten when the wrist is allowed to drop

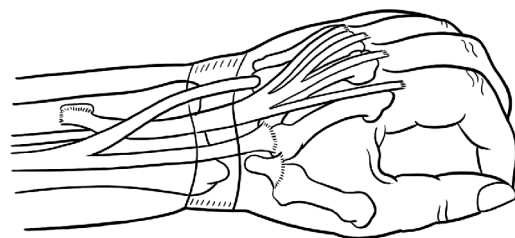


FIGURE 8-10 Hinge hand procedure. Attachment of finger extensors to ulna (from Warren³³, used with permission).

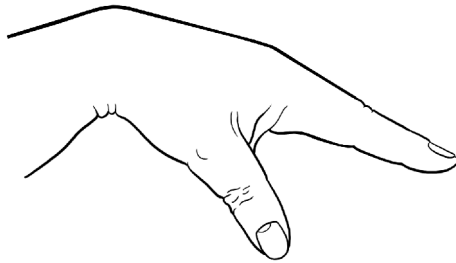


FIGURE 8-11 Hinge hand procedure. Flexion of wrist produces finger extension and thumb extension and abduction (from Warren³³, used with permission).

towards flexion (Fig. 8-11), but to flex at the MCP and IP joints when the wrist is extended. The exact tension that can be applied will depend on what the tension is in the flexor tendons. This can easily be tested on the table before final suturing and closure.

The arm is plastered with wrist fully extended and the fingers straight as is done for the pronator teres splint. If the thumb has also been operated on it will require to be held in abduction and opposition. The plaster ought to be above elbow especially if ECRB or BR is the used motor.

Physiotherapy is relatively easy. The cast is left on for 4 weeks and then the transferred wrist extensor is re-educated. The fingers will automatically activate so that when the wrist extends the fingers flex, and when the wrist flexes the fingers extend and the thumb is abducted and extended.

SUMMARY

While radial nerve palsy, and especially combined nerve palsies, are a serious disability, surgery for these conditions is usually very rewarding. Careful attention to technique is essential to achieve correct balance, and skilled therapy is necessary to achieve a good result.

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