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THE PROXIMAL INTERPHALANGEAL JOINT IN DUPUYTREN'S DISEASE

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ANATOMY AND PATHOLOGY OF PROXIMAL INTERPHALANGEAL JOINT CONTRACTURE IN DUPUYTREN'S DISEASE

Contracture of the proximal interphalangeal (PIP) joint in Dupuytren's disease initially occurs as a consequence of the primary disease process. With longstanding disease, secondary changes develop in the joint and surrounding structures, which have been held in a shortened position but usually are not directly infiltrated by Dupuytren's tissue.

Primary Flexion Contracture

The primary flexion contracture in Dupuytren's disease is directly related to the anatomy of the palmar digital fascia and the pattern of fascial involvement in the disease process.[25, 26, 33] McFarlane[25] described the course and attachments of diseased fascial cords within the finger and the relationship of these cords to the normal digital fascia. He studied the specific cords responsible for metacarpophalangeal (MP) and PIP joint contractures. He described the digital fascia as a more or less tubular structure, enclosing the flexor and extensor tendons by fibers that course transversely, obliquely, and longitudinally. Parts of this fascia become condensed into bands that can be demonstrated clearly by dissection (Fig. 1). The pretendinous band of the normal palmar aponeurosis inserts into the skin just distal to the MP joint, with some fibers inserting into the fibrous flexor sheath and other, fan-like communications joining the lateral digital sheet and Cleland's ligaments deep to the neurovascular bundle via oblique bands. The natatory ligament, which forms the fascial substance of the web space, also sends fibers distally along the sides of the finger, connecting with Grayson's ligaments. These lie superficial to the neurovascular bundle.

According to McFarlane,[25] Dupuytren's disease results in three pathologic cords—central, lateral, and oblique. Each of these cords may flex the PIP joint via attachments to skin, tendon sheath, palmar plate, and phalanges. Grayson's ligaments frequently are infiltrated by Dupuytren's tissue, whereas Cleland's ligaments are diseased less often. Landsmeer's ligament seldom is affected by the primary disease process, but may contribute to secondary contracture through its oblique direction, crossing from the distal aspect of the proximal phalanx and flexor tendon sheath to the extensor tendon over the middle phalanx.

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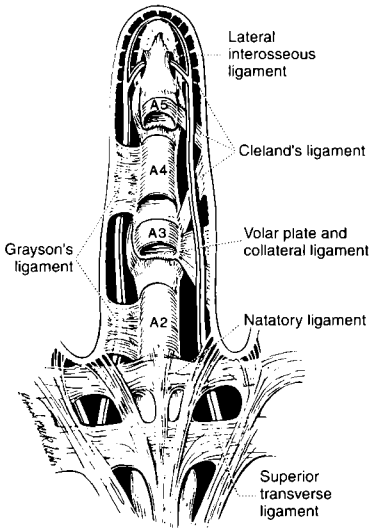

Figure 1. The digital fascia. The lateral digital sheet connects the retaining ligaments of Grayson and Cleland with extensions of the palmar fascia. Disease of a continuation of the pretendinous band (inserting into the skin and fibrous sheath distal to the metacarpophalangeal joint), spiral band (connecting with the lateral digital sheet), and lateral digital sheet itself results in a proximal interphalangeal joint flexion contracture. (*Reprinted from* Tonkin MA, Burke FD, Varian JPW: The proximal interphalangeal joint in Dupuytren's disease. J Hand Surg [Br] 10:358, 1985; by permission of the publisher Churchill Livingstone.)

An additional pathologic cord causing PIP joint contracture was described by Strickland.[15] The isolated digital cord arises and terminates entirely within the digit, with no proximal fascial attachment. This cord originates from the periosteum at the base of the proximal phalanx and from the intrinsic muscle tendon insertion. It is found most commonly in the little finger, arising from the tendon of abductor digiti minimi. The cord proceeds distally in an oblique manner, initially lying dorsal to the neurovascular bundle and then crossing palmar to the bundle in the distal part of the proximal phalanx, displacing the bundle toward the midline prior to crossing. The cord inserts into the flexor tendon sheath or periosteum of the middle phalanx, with fibers occasionally inserting distal to the distal interphalangeal (DIP) joint, which may result in flexion contracture of the DIP joint as well. It often involves the skin adjacent to the PIP joint and may envelope the neurovascular bundle, which is at risk during dissection. Isolated digital cords may be bilateral.

Secondary Contracture

The MP joint flexion deformity nearly always corrects following excision of the diseased fascia, whereas the PIP joint may not. Both joints have collateral and accessory collateral ligaments, a fibrocartilaginous palmar plate, and a dorsal capsule of synovial tissue guarded by an extensor expansion. The anatomy of each joint differs, however.[4, 19, 20] The ball-and-socket configuration of the MP joint allows flexion, extension, abduction, adduction, rotation, and circumduction. Passive hyperextension is possible, a consequence of the loose attachment of the MP joint palmar plate to mobile structures.

The hinge joint anatomy of the PIP joint allows mainly flexion and extension. Furthermore, the palmar plate of the PIP joint is firmly attached to the base of the middle phalanx, and check ligaments provide strong connection to the neck of the proximal phalanx. These features limit passive hyperextension of the PIP joint in most patients of northern European extraction.

The collateral ligaments of the MP joint are at their maximum length in the flexed position. The PIP joint collateral ligaments are not lengthened in flexion and may contract and adhere when the joint is maintained in a flexed position. These anatomic features predispose the PIP joint to flexion contracture that may persist following excision of diseased fascia.

A number of different structures may contribute to the secondary joint contracture[9, 15]:

Shortening of Skin Over the Palmar Aspect of the Finger. This is a result of fascial attachments to skin. Skin may be involved by disease and often is inseparable from the underlying diseased tissue. Scarring from previous surgery also may cause skin contracture.

Contraction of the Flexor Sheath. This is caused by infiltration by the disease process and adherence of the mobile portion of the

sheath between the A2 and A4 pulleys. The sheath in this region is less rigid and its length alters during flexion and extension of the PIP joint. This is prevented when the sheath is contracted or adherent.

Shortening of the Flexor Muscles. In many instances, PIP joint contracture caused by shortening of the flexor muscles can be corrected passively by flexing the wrist and MP joints, allowing the flexor muscle tension to relax.[34] In longstanding MP and PIP joint contractures, secondary changes in elasticity within extrinsic and intrinsic muscle fibers can decrease their excursion. Resting fiber length is diminished. The scar of previous surgery may limit flexor tendon excursion. The flexor digitorum superficialis (FDS) tendon, in particular, may adhere to the proximal phalanx and palmar plate, contributing to flexion contracture.

Contraction and Adhesion of the Palmar Plate. Secondary thickening of the check ligaments creates a checkrein across the joint. These are pathologic, usually paired structures that may differ in size or tightness.[40]

Adhesion of the Retinacular Ligament of Landsmeer to the Collateral Ligaments. The oblique component of the retinacular ligament passes palmar to the PIP joint axis of rotation during flexion, and adherence in this position prevents both extension of the PIP joint and flexion of the DIP joint, creating a boutonnière deformity. Contracture of the transverse retinacular ligament draws the lateral bands palmarward, contributing to the deformity.

Contraction and Adhesion of the Collateral and Accesory Collateral Ligaments. During PIP joint flexion, the palmar aspect of the collateral ligament complex tightens. Shortening may occur with periods of sustained PIP joint contracture secondary to primary Dupuytren's disease.

Intra-articular Changes in the Proximal Interphalangeal Joint. Longstanding PIP joint flexion results in adaptive changes in the dorsal compartment of the PIP joint.[11] There is loss of articular cartilage and subchondral bone from the part of the proximal phalangeal head that has lost contact with the base of the middle phalanx. The extensor tendon becomes adherent to the dorsal half of the head of the proximal phalanx and causes obliteration of the dorsal compartment of the PIP joint space. These changes prevent restoration of full extension.

MANAGEMENT OF PROXIMAL INTERPHALANGEAL JOINT DEFORMITY IN DUPUYTREN'S DISEASE

McFarlane[25] found that careful and systematic excision of the diseased fascia within the finger corrected PIP joint contractures in almost all cases of Dupuytren's disease. Only one of his 64 patients required a capsulotomy. The number of publications addressing methods of management of recalcitrant PIP joint contractures following fasciectomy suggests that all have not had the same success.* Furthermore, recurrence of disease following surgery occurs frequently. Recurrence of deformity is less common but, in particular, affects the PIP joint of the little finger. In such instances, scarring from previous surgery and the nature of the joint itself play a significant role. It is important to differentiate inability to correct the deformity by excision of fascia at the time of surgery from recurrence of deformity postoperatively. The latter may result from the inherent nature of the joint to flex or from recurrent disease.

The methods of management of PIP joint flexion contracture in Dupuytren's disease are detailed in the following pages. Where appropriate, the authors have indicated their experience with, and preference for, certain procedures.

Timing of Surgery

Most MP joint contractures, no matter how severe and even when longstanding, can be corrected by excision of the diseased fascia, for the reasons given in the preceding pages. The indication for surgery for these patients is disability. What is disabling for one may not be for another, so the indication for surgery varies. Most believe, however, that longstanding and severe PIP joint deformities are more difficult to correct with time. Some advise surgery for any PIP joint contracture. This seems a little harsh, particularly in the elderly. An assessment of the disease diathesis, in combination with the rate of progression, is important in making the decision, particularly because complications of delayed healing and joint stiffness are common. Two questions should be asked of the patient: (1)

*References 1, 3, 5, 6, 11, 13, 15, 16, 21, 22, 27–31, 38, 41, 42.

Is the current deformity causing a functional problem? If it is, surgery may be indicated. (2) Would progression of the contracture become a functional problem? If the answer to this question is yes, surgery is appropriate earlier rather than later.

It is no longer the authors' practice to specify that a particular angular deformity is an indication for surgery. It is our experience that PIP joint flexion contractures of 30° or even greater, in the absence of MP joint contractures, are well tolerated. It therefore is now uncommon for the authors to advise surgery for isolated contractures of 30° or less. More commonly, a PIP joint deformity is accompanied by MP joint deformity. The questions of disability or pending disability with progressive contracture then apply.

Preoperative Assessment

A careful clinical examination in most instances reveals the cords responsible for the PIP joint deformity. An isolated digital cord may accompany a pretendinous cord in continuity with disease in the palm and be less than obvious. When palpating the cords, the descriptions of McFarlane[25] and Strickland,[35] which assist in determining the anatomic cause of the contracture and the relationship of the cord to the neurovascular bundles, should be kept in mind. A proliferative nodule overlying the proximal phalanx is common, often intimately involved with the skin. Mobility of skin over an underlying cord should alert the clinician to the possibility of a spiral nerve lying between the skin and the diseased tissue. The continuity of diseased fascia in the superficial planes connecting with diseased fascia in the digital retrovascular plane, usually via a connecting oblique cord, similarly indicates a neurovascular bundle at risk.

In recurrent disease, the neurovascular bundle is at greater risk. The preoperative assessment should include documented assessment of the status of the neurovascular bundles.

The clinician must be aware of the particular diathesis of the disease in the individual patient because it is indicative of a likely rate of disease progression and the likelihood of recurrence following surgery. The diabetic hand, in which there is a collagen abnormality secondary to a nonenzymatic glycolization of collagen, responds relatively poorly to surgical injury, with a greater likelihood of joint stiffness and thicker scar formation. The alcoholic patient may not be able to comply with postoperative therapy. A previous injury to the finger, particularly the PIP joint, may prevent correction. It is recommended that a lateral radiograph of the PIP joint be obtained prior to surgery in longstanding PIP joint contractures.

Surgery for the Primary Flexion Contracture[8, 12, 23–25]

Skin incisions should be planned to minimize the possibility of skin necrosis. Many are described. Some favor Bruner or half-Bruner incisions. Where skin is short, a V to Y lengthening of skin over the proximal phalanx in the longitudinal plane is possible. Bedeschi's "honeycomb" incision incorporates a Bruner with lateral darts. The authors prefer a midline longitudinal incision with the creation of subsequent Z-plasties to prevent scar contraction at the joint creases. Tip necrosis of the flaps is possible. Following fasciectomy, the surgeon needs to assess the viability of the skin. The possible necessity for full-thickness skin grafts or local flaps should be considered preoperatively.[10, 17]

Fasciectomy in the digit should be complete, including pretendinous nodules and cords, and retrovascular cords. Particular attention should be directed to the dorsolateral extensions of diseased fascia at the level of the PIP joint via Cleland's ligaments and the lateral digital sheet. Exostosis formation may be found at the insertion of cords to the base of the middle phalanx laterally. The presence of an isolated digital cord should be sought. It may be the reason for failure of correction following removal of more superficial disease. The integrity of the flexor tendon sheath should be maintained, if at all possible. The disease invades both the sheath and the skin, however, and it is difficult to achieve complete removal without compromising one or both components.

Dermofasciectomy decreases disease recurrence and is indicated in some young patients with a strong disease diathesis. It is commonly practiced when there is infiltration of skin by diseased tissue and compromise of viability following fasciectomy.[14, 17, 36] When dermofasciectomy is considered a possibility, the integrity of the flexor tendon sheath becomes more important because skin grafts

may be compromised when placed on bare tendon.

Fasciotomy has a limited role in PIP joint correction. Tubiana[30] cautioned against its use at this level. Colville[8] reported good success from fasciotomy in carefully selected patients. He advocates fasciotomy in the proximal phalanx only when the Dupuytren's cord is well defined and displays bow-stringing. Absence of bow-stringing implies extension from the main cord or deeper structures and such cases are not suitable for the procedure. It is possible to consider a fasciotomy through minimal incisions but the risks of neurovascular injury are increased.

Surgery for Secondary Contracture

If meticulous excision of the diseased fascia fails to release the PIP joint adequately, release of one or more of the structures contributing to secondary joint contracture may be necessary. Careful clinical assessment can help differentiate among skin contracture, fascial contracture, flexor muscle shortening, tendinous adhesions, and capsuloligamentous contracture.[9] The choice of sequence for release of contracted structures varies among authors. Andrew[1] reported a cadaveric study of fixed PIP joint flexion deformity in seven fingers amputated for Dupuytren's disease. He sequentially released 10 structures implicated in the etiology of secondary PIP joint contracture. He consistently found that PIP joints would extend fully after release of the accessory collateral ligaments and palmar plate. Complete proximal release of the palmar plate, however, led to instability, with the PIP joint snapping from 45° of flexion into 10° of hyperextension. This was abolished by sectioning the lateral bands of the extensor tendon in three fingers and, in the remaining fingers, was prevented by section of part of the origin of the true collateral ligament.

Tonkin et al[37] stressed the importance of the flexor tendon sheath. Because the structure crosses the MP and PIP joints, its infiltration by Dupuytren's disease causes joint contracture. Even in the absence of direct infiltration, the mobile portion of the sheath between the A2 and A4 pulleys contracts and shortens. In such cases, excision of a window of sheath is required to provide adequate release. This results in an area of bare tendon. If skin grafting is planned, it is preferable to design skin incisions so the tendon can be covered by a skin flap rather than a graft.[30] A cross-finger flap also may be useful, as described by Moberg, but stiffness may be a complicating factor because of immobilization.[28] Adhesions of the FDS tendon to the proximal phalanx at the palmar plate should be released. The retinacular ligaments are dissected free of the collateral ligaments. The oblique component may require division. Palmar plate contraction may be caused by the pathologic check-rein ligaments or tightness of the accessory collateral ligaments. Although these structures usually are not directly invaded by Dupuytren's tissue, recurrent disease may be difficult to separate macroscopically from the scarring of previous surgery.[37]

Watson[40] described the check-rein ligaments and the surgical technique for their release through either midlateral or volar V-Y incisions. The ligaments are excised, preserving the continuity of the palmar plate, the transverse communicating vessels, and the joint integrity. Stanley[34] reported a percutaneous technique for release of the accessory collateral ligaments but emphasized that, although the technique allowed operative correction of flexion deformity, a stringent postoperative regimen was required to maintain correction. If the proper collateral ligaments are completely divided, subluxation of the middle phalanx may occur.

Several authors have questioned the efficacy of an aggressive approach to secondary joint contracture. Weinzweig et al[42] found no significant improvement in correction of deformity in 15 joints undergoing fasciectomy and capsuloligamentous release in 27 joints undergoing fasciectomy alone. Complications were more common in the capsulotomy group.

Breed and Smith,[6] in 1996, analyzed methods of treating residual PIP joint flexion deformity in 75 patients. They showed that gentle passive manipulation (GPM) gave better results and fewer complications than more aggressive surgical intervention. The other methods employed in their study were surgical release of the PIP joint, PIP joint release combined with extensor tendon reconstruction, and no other PIP joint procedure. The GPM method uses a gentle, sustained (2 min) manipulation of the PIP joint into extension with the MP joint flexed. The authors stress that excessive force should not be used and only minor periarticular adhesions should be ruptured. An 84% improvement in joint angle

was recorded in the GPM group, as opposed to 68% in the PIP joint release group, 53% in the extensor tendon repair group, and 63% in the group in whom no other PIP joint procedure was performed. Recurrence rates also differed among groups, with 25% in the manipulation group, 33% in the joint release group, 60% in the extensor tendon repair group, and 67% in the group in whom no further PIP joint procedure was performed. Follow-up periods were not comparable for these groups, however.

If excision of the diseased fascia fails to achieve correction, the authors' current practice is to apply GPM. Correction to 30° is considered satisfactory because most PIP joints undergoing a joint release tend to return to this position in the relatively early postoperative period. This therefore is not attributable to recurrence of disease but, rather, to the response of the joint to the surgical insult. Only in those patients in whom correction to 30° cannot be obtained by excision of fascia plus or minus gentle manipulation is a joint release considered. If the skin and flexor tendon sheath have been dealt with, then it is the authors' practice to release the checkrein ligaments as suggested by Watson, then proceed to mobilizing the collateral ligament–accessory collateral ligament complex from the head of the proximal phalanx and the joint itself without dividing the collateral ligament proper (Fig. 2). This capsular release is now an uncommon procedure in the authors' hands.

Ultimately, shortening of the neurovascular bundles may limit release. It is vital to check digital circulation, particularly if the PIP joint is to be fixed in extension as part of the postoperative program. It may be necessary to place the finger in less than the fully corrected position if vascular compromise exists.

Preoperative Distraction

Messina[27] introduced the concept of continuous elongation prior to fasciectomy for Dupuytren's disease, aiming to lengthen the fascia and return it to the early stages of the disease process. An apparatus known as the *Technica di Extensiona Continua* (TEC) device was designed and mounted on self-drilling transverse pins in the fourth and fifth metacarpals and a K-wire traction loop through the middle or distal phalanx. A threaded screw attached to the phalangeal traction loop allowed 2-mm lengthening of the contracted finger per day.

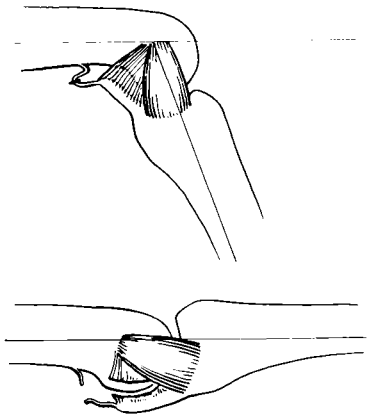

Figure 2. Release of secondary flexion contracture by division of the check rein ligaments of the palmar plate and the accessory collateral ligaments. (*Reprinted from* Tonkin MA, Burke FD, Varian JPW: The proximal interphalangeal joint in Dupuytren's disease. J Hand Surg [Br] 10:358, 1985; by permission of the publisher Churchill Livingstone.)

Using the TEC technique as the only form of treatment in 15 patients resulted in initial correction of contracture. Following removal of the device, however, the contracture rapidly (average 10 days) recurred in nine patients. At 3 months, the flexion deformity had progressed but was still less than that prior to distraction.

A further 41 patients were treated by TEC elongation followed by limited fasciectomy. It is recommended that fasciectomy be carried out as soon as possible postdistraction to avoid the tendency for rapid retraction. Using this method, eight patients developed recurrent disease and five presented with disease extension. The patients represented those at the most severe end of the disease spectrum, in whom amputation might have been considered. Other advantages observed with this method were improvement in skin elasticity and trophism, and elongation of the skin, avoiding the need for skin grafts or flaps.

Light and electron microscopy studies of the elongated palmar fascia were performed and compared with nonelongated samples from patients of a similar disease stage.[7] Nodules and cords were no longer clinically recognizable after elongation. Distracted tissue contained collagen fibrils of uniform diame-

ter, densely packed in fibers parallel to the stretching force, with fibroblasts and myofibroblasts aligned along the collagen fibers. There was no evidence of collagen fiber interruption or hemorrhage, suggesting that a dynamic biological process was responsible for the increased length of fascia.

Biochemical studies following continuous elongation have demonstrated an increase in levels of degradative enzymes that act to depolymerize collagen, leading initially to loss of tensile strength and ultimately to solubilization.[2] The increase in enzyme activity results from tension on fibroblasts. The weakening of fibers and increase in newly synthesized collagen explain the lengthening of the tissue without trauma.

Hodgkinson[15] described an alternative skeletal traction device to correct the flexed PIP joint in Dupuytren's disease. Less cumbersome than Messina's device, he named it the *Pipster* (proximal interphalangeal skeletal traction extender). The Pipster is attached to two K wires inserted percutaneously under local anaesthesia. One wire passes transversely through the head of the middle phalanx and the other through the base of the proximal phalanx. The fixation points are separated by turning a knob. In a pilot study of seven fingers in five patients, a preoperative improvement of at least 45° of flexion contracture was measured. The technique was effective in primary and recurrent disease. Subsequent surgery was facilitated and amputation avoided in five fingers. Surgery was performed on the next available list after removal of the device.

Complications related to distraction devices documented by Messina include subluxation of the interphalangeal joint in one patient and three cases of swan-neck deformity of the PIP joint after fasciectomy. The device was removed from one patient because of poor tolerance for the elongation process. No pintract infections were reported. Two minor complications were seen with the Pipster device—a skin ulcer in a patient who dug his garden with the device in place and a case of self-removal of wires by one patient when treatment was nearly complete.

The Extensor Mechanism

The extensor mechanism is often forgotten in Dupuytren's disease but may be important to outcome. Andrew,[1] in his cadaveric study, remarked on the condition of the extensor tendon. In full extension, the central slip was seen to be ballooned and stretched over the PIP joint. Tension applied to the common extensor tendon only tightened the central slip after the lateral slips had been sectioned. The boutonnière deformity in Dupuytren's disease was found to be caused by fibrous contraction of the transverse retinacular ligament, which displaced the fibers of the extensor apparatus in a palmar direction.[21] Adherence of the oblique retinacular ligament contributes to the deformity.

Smith and Breed[31] stressed the importance of central slip attenuation in the management of Dupuytren's contracture. They suggest that this may account for relapse of PIP joint contracture in spite of full correction at the time of operation. The central slip tenodesis test is a noninvasive, passive test that can be used to assess central slip integrity preoperatively, intraoperatively, and in postoperative follow up.[32] The wrist is placed in full flexion. The examiner then places a finger on the dorsum of the proximal phalanx of the finger in question and, by exerting gentle pressure, flexes the MP joint. With an intact central slip, this causes passive extension of the PIP joint because of the tenodesis effect. When the central slip is deficient, the maneuver elicits an extensor lag. Patients with documented central slip attenuation had a postoperative rehabilitation of static PIP joint extension splinting for 3 weeks with the DIP joint free, followed by a soft-capener splint for 3 weeks. Active daytime mobilization and night-time PIP joint extension splinting were continued for a further 4 to 6 months.

Secondary changes in the extensor mechanism also were recognized by Hueston,[18] who recommended use of a lively splint after surgery.

The extensor mechanism at the DIP joint also may be dysfunctional in Dupuytren's disease. There are two main reasons for this. First, a plaque of Dupuytren's disease may be present beneath the extensor tendon over the middle phalanx. Second, because the extensor force bypasses the PIP joint, hyperextension deformity may arise at the DIP joint. This can be corrected by an extensor tenotomy over the dorsum of the middle phalanx, which also helps restore the balance of the extensor mechanism at the PIP joint.

Postoperative Management

Correction of PIP joint flexion contracture may be achieved at surgery but the inherent

tendency for the PIP joint to adopt a flexed position may lead to relapse of the contracture if left to its own devices. Many individual postoperative regimens exist, from simple static splintage to external distraction techniques.

Static splints are used most commonly in the early postoperative management of PIP joint deformity in Dupuytren's disease. The splint may be palm-based or wrist-based and removable to allow early mobilization of the hand. Serial adjustments can further improve PIP joint extension in some patients. As rehabilitation progresses, the splint may be limited to night-time use. There is great variation in reported duration of splint usage, with some authors discontinuing use within 3 months of surgery and others favoring long-term, night-time splint treatment.

Dynamic splints are useful for some contractures. Smith and Breed[31] used a capener splint for 3 to 6 weeks after surgery for cases complicated by extensor central slip attenuation. Rives[29] reported results of a prospective study of operative correction of PIP joint contracture followed by dynamic extension splinting. The splint used in this study was a dorsal plastic splint extending from fingertip to midforearm. It was worn continuously for the first 4 weeks after surgery and subsequently intermittently for 6 months. Although the authors expressed satisfaction with the results of the regimen, there was no control group in the study other than a group of noncompliant patients. Compliance is an important issue when designing postoperative regimens, especially if the treatment appliance is cumbersome and interferes with activity. Unless a definite functional gain can be expected, it may be difficult to enforce such regimens.

Temporary Kirschner (K)-wire fixation may be useful in joints that are unstable following release of contracture and also hold a joint in a corrected position while skin healing occurs. Most authors advise removal of wires within 3 weeks of surgery to avoid stiffness. Digital circulation must be examined following insertion of the K wire to avoid excess tension on the neurovascular bundle. If there is any circulatory compromise, the joint should be positioned in greater flexion to restore blood supply. The authors rarely use a K wire because of concern about loss of flexion following such fixation. On occasion, however, temporary fixation is maintained for a maximum of 5 days in cases in which it is considered that the extrinsic and intrinsic musculotendinous units need some time to adapt to their lengthened position.

Sampson,[30] in a prospective study, evaluated the use of a passive motion machine versus standard hand therapy in the postoperative rehabilitation of 38 patients. Continuous passive motion patients had a 52% correction of contracture, versus 47% in control patients. The authors concluded that the passive motion machine did not appear to be of clinical or economic benefit.

Beard and Trail[3] reported use of the "S" Quattro (Fahmy, Stockton, CA) external fixation device, which includes percutaneous pins attached to distraction and compression springs, in 18 fingers treated by limited fasciectomy for severe PIP joint contracture. The device was applied if a contracture of greater than 40° persisted after fasciectomy. Seventeen of the 18 patients demonstrated an initial improvement in deformity, but there was significant recurrence in eight patients within 1 year of surgery and only five patients maintained improved function long term. A high complication rate was associated with this method of treatment. Three patients developed pin-tract infections, one leading to removal of the device 9 days after surgery. An additional patient had the device removed at 7 days because of loosening. Localized pain and discoloration at the site of the proximal pin was a complication in another.

Scar massage assists in softening and maturation of scars, and may help prevent secondary contracture of the skin following surgery. GPM of the digit in the postoperative period also can assist in restoring range of motion and in graded extension of the PIP joint.

A description of the authors' preferred postoperative method follows. The forearm and hand are rested on a palmar splint with the wrist extended 30°, the MP joints flexed to 30°, and the interphalangeal joints as extended as possible. Gentle active motion begins at 48 hours, depending on the state of the skin. Day splinting usually is discontinued at the time of removal of sutures (3 weeks). Night splinting may be continued for up to 3 months. It is halted earlier if there is no tendency for recurrence of deformity. In fingers tending to recurrence, a three-point, static-extension splint is used in which a dorsal PIP joint strap is incorporated into the splint to apply some tension during the healing phase. Dynamic splintage is used if these methods are not satisfactory—that is, in patients who

achieve full correction but who tend to contract subsequently or those in whom correction is obtained to 30° but regresses postoperatively. This splinting is continued until a plateau of function is maintained.

Salvage Procedures for the Proximal Interphalangeal Joint

Moberg[28] offered three surgical alternatives to amputation for patients with advanced Dupuytren's contracture, often attributable to recurrent disease—namely, a cross-finger flap, arthrodesis, and osteotomy. Palmar skin in such cases may be heavily scarred and scar infiltration of the deeper structures may make surgery on the palmar side of the finger impossible. A cross-finger flap is useful when sufficient skin cannot be mobilized from the palmar side of the finger or when it is nonviable after fasciectomy. The incisions are planned so the skin defect is located over the proximal phalanx. Emphasis is placed on the size of the flap to be raised from the dorsum of the adjacent finger. It must be large enough to reach the midlateral line of the recipient finger. Furthermore, the base of the web must be preserved. Moberg[28] recommended delaying flap separation for several months, claiming that too early a separation results in persistent edema of the flap and subsequent fibrosis. He stated that patients have minimal problems with this temporary syndactylism and it usually does not prevent an early return to work. This may be effective as an alternative to amputation. Finger stiffness is common, however.

Joint arthrodesis is especially useful in the little finger, where Moberg[28] recommends resection of the PIP joint with a 1- to 1.5-cm shortening and an arthrodesis in 25° flexion. His described technique uses a bone peg from the proximal ulna for arthrodesis. At 6 weeks, the finger is usually stable, painless, and in a more functional position. The now-more-extended PIP joint permits the patient to use gloves and prevents the digit from catching on pockets. MP joint flexion compensates well for loss of active PIP joint flexion. If the MCP joint hyperextends, a more flexed position of arthrodesis may be appropriate.

This technique also has been advocated by Watson,[41] who reported results of PIP joint fusions in 14 joints of 11 patients.

Wedge osteotomy removes a dorsal wedge from the proximal phalanx, also shortening the digit. The PIP joint range of motion remains the same, but its arc of motion is moved to a position of greater extension, which is better for function (Fig. 3).

PIP joint arthroplasty was reported as a salvage procedure by Haimovici,[13] who followed 34 patients in which a palmar soft-tissue release was combined with the insertion of a Swanson prosthesis. Good results (range of motion >60° with a stable, painless joint) were obtained in 73% of cases. A 40° arc of motion was achieved in 90% of cases. Tonkin and Lennon[38] described a case of Dupuytren's disease in which a combination of dermofasciectomy and PIP joint replacement using the Swanson prosthesis improved hand function and avoided further digital amputation. Full extension is rarely maintained postoperatively, however. This technique may have a role for the well-supported digits—that is, the middle and ring fingers—but for the less-supported digits—the little and index—greater stability is required and they may be better served by arthrodesis or osteotomy.

The authors believe that PIP joint replacement arthroplasty is rarely indicated. Arthrodesis is suitable in some patients, particularly if the MP joint deformity is corrected, allowing some hyperextension of that joint. The authors favor shortening of the skeleton and a tension band wire technique. A dorsal wedge osteotomy may place the finger in a better position but does not prevent recurrence of deformity with progressive disease.

Amputation is rarely necessary with adherence to the principles described previously. Repeated surgery to a scarred, contracted little finger that interferes with a patient's function, however, may not be in a given patient's interests. The concern, of course, is that progressive disease may lead to consideration of additional amputations, which should be avoided. Removal of the useless little finger is of benefit in providing dorsal skin that can be used to replace skin in the palm overlying the ring finger ray.

CONCLUSION

A careful examination reveals the cause of a PIP joint contracture. Precise excision of the diseased fascia corrects the deformity in many instances. The surgeon must be aware of the possibility of an isolated digital cord. When excision of the fascia results in a con-

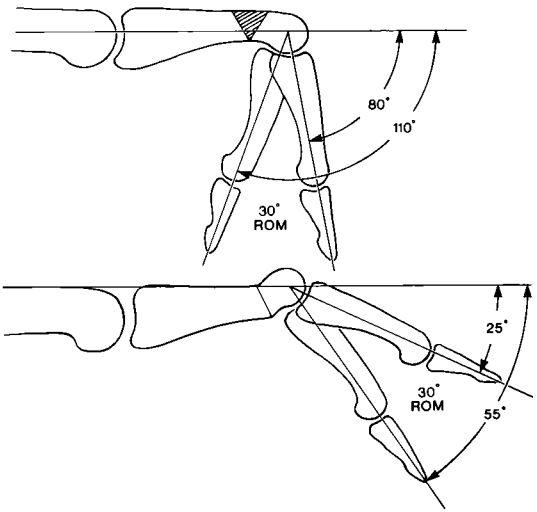

Figure 3. Correction of deformity by dorsal wedge osteotomy. The arc of motion is rotated dorsally. (*Reprinted from* Tonkin MA, Burke FD, Varian JPW: The proximal interphalangeal joint in Dupuytren's disease. J Hand Surg [Br] 10:358, 1985; by permission of the publisher Churchill Livingstone.)

tracture of greater than 30° that is not corrected to that level by gentle manipulation, then a systematic release of the causative structures occasionally is indicated, paying particular attention to the check-rein ligaments of the palmar plate and adherence of shortened collateral and accessory collateral ligaments. Postoperative physical therapy and splinting are necessary, particularly in cases in which a joint release has been performed. These authors advise against a routine joint release. Ultimately, the failure to regain flexion may be a greater disability than the original loss of extension.

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