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Introduction

Definition

Dupuytren disease (DD) is a benign fibromatosis of the palmar fascias in which nodules and skin pits in the distal palm are usually the first signs. As it progresses, cords are formed which in time may contract limiting extension of the fingers and causing webspace contractures. The disease usually starts in the ring finger and little finger ray, but may affect any ray in a variable pattern. The same is true for the age at which the first symptoms occur. In the majority of cases the disease emerges in people of over 50 years of age. In the younger age groups, males are more affected than females. Systematic meta-analysis of the published work on prevalence has revealed it to range from 0.6 to 31.6%.[1] The disease may affect all races, although prevalence of DD has not been studied extensively in other than Caucasian races (only incidence reports).

Similar fibromatoses may affect the fascias in the instep area of the foot (Ledderhose disease (LD)), the penis (Peyronie disease (PD)), and the knuckles of the finger joints (Garrod pads). LD can cause pain during walking. Toe contractures are only sporadically seen. In PD contraction of plaques formed within the tunica albuginea may cause penile curvature during erection, sometimes hampering sexual intercourse.

Impact of DD and its Reflection in Patient-Rated Outcome Measures

The impact of DD on the patient varies with the demands the patient has. Awkwardness and functional incapacity are usually direct consequences of increasing contracture, especially when the total extension deficit of a finger exceeds 90 degrees, turning the finger into a hook that inadvertently catches objects, that cannot be easily released. Specific common complaints may be difficulty to put on gloves or getting one's hand into a pocket, eye poking with the bent fingers during facial wash and embarrassment in social hand shaking. Dupuytren contractures may interfere with various job-specific tasks and functionally impair in numerous ways.[2] Primary DD in general does not limit finger flexion.

It is not easy to quantify the disabilities, since most general upper limb impairment scores do not reflect the specific impairment of the contractures, nor their effect on performance of activities or quality of life. There are a few disease-specific questionnaires, but they have been found to have their limitations in use too.[3]

Variable Disease Course of DD

In the majority of DD cases contractures do not develop and it is good to realize that in clinics a subset of the affected population is seen; those who become patients do so mostly because they have developed contractures. Within this group, a further subset of patients can be distinguished that challenges surgeons the most, due to an aggressive disease course (Dupuytren diathesis): in these patients, whose family members often also are affected, the disease typically starts at a young age, affects both hands, also involves the radial side of the hand and is commonly associated with fibromatoses such as knuckle pads, PD and LD.[4] Since these patients develop contractures earlier in life, treatment is often needed at a younger age. Because the disease activity is higher, they often develop (early) recurrences – especially of the little finger – which may demand additional and repeated surgery, which ultimately may inflict damage to neurovascular (NV) bundles and even gangrene.

In the symptomatic population in general, DD is often found to recur or progress and should therefore be regarded as a chronic disease that at present cannot be cured. Therefore, a thoughtful individually tailored treatment strategy is indispensable. On one hand, the aim is to correct the disabling contractures with as minimally invasive treatment options as possible. On the other hand, more aggressive measures sometimes need to be considered in those cases, where recurrence is almost inevitable. This chapter aims to summarize the current knowledge of the various aspects of this disease and give some guidelines for treatment.

Surgical Anatomy of the Palmar Fascia and Changes Found in DD

McFarlane and McGrouther have to be credited for pointing out the anatomical basis of most of the fascial structures

relevant for DD and for relating them to what may be expected at surgery.[5,6]

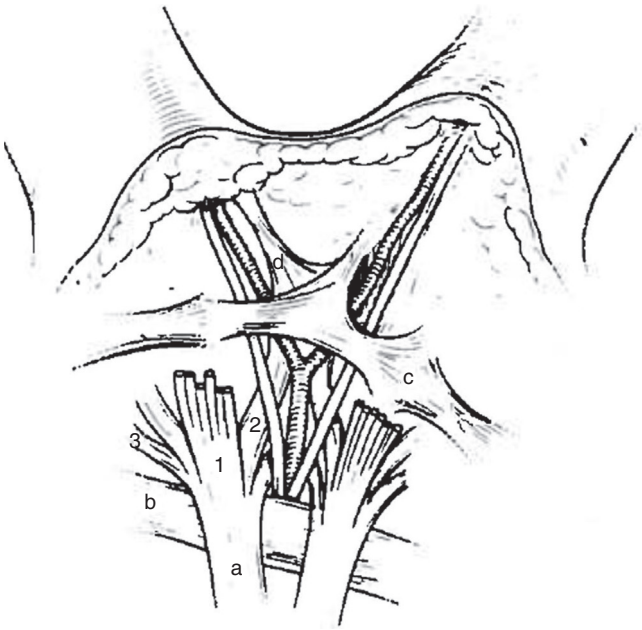
Palmar and Digital Fascias

In the palm the normal fascial structures form a three-dimensional network consisting of longitudinally, transversely, and sagittally running fibers. The longitudinal fibers are organized in a triangle and form the palmar aponeurosis. In this triangle, pretendinous and prelumbrical bands can be distinguished, the former being more condensed than the latter. They all pass superficial to the transverse ligament of the palmar aponeurosis (TLPA), which is situated at a line joining the proximal and distal palmar crease. The ulnar border of the TLPA forms a crossroad with fibers of the hypothenar fascia and the radial border is continuous with the proximal commissural band, which runs through the first webspace and ends in the thenar fascia at the level of the first metacarpophalangeal joint. Just beyond TLPA, the pretendinous bands divide into three layers (Fig. 55.1). Layer 1 is the most superficial layer, which has its insertion in either the skin of the distal palm or the proximal phalanx. Layer 2 fibers form the so-called "spiral band," since it spirals around the NV bundle on its course towards the finger. This band is present on both sides in all long fingers, except for the ulnar side of the little finger. Layer 3 is the deepest layer of fibers, which takes a sagittal course into the hand on both sides of the flexor tendon sheath to insert on either side of the corresponding metacarpophalangeal (MCP) joint.

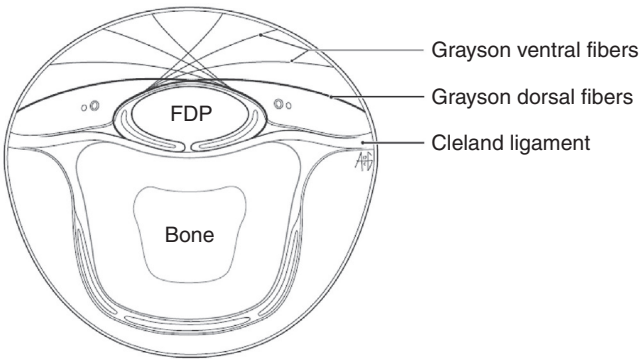
Another important transverse fascial structure is the natatory ligament (NL). This ligament lies just underneath the skin in the distal palm and is situated superficial to the NV bundles (see Fig. 55.1). On its ulnar end it is continuous with the hypothenar fascia, and on the radial side with the distal commissural band. NL has attachments to the flexor tendon sheet, lines the webs, and has extensions along the lateral sides of the digits. It also blends with fibers from the spiral band and is continuous with the lateral digital sheet. It is important not only because it may be affected, but also because its proximal border defines the place where a spiral nerve superficially crosses a spiral cord, making it vulnerable during surgery.

The vertical or sagittal ligaments in the palm worth mentioning are the septa of Legueu and Juvara that are usually just as wide as TLPA and, except in the thumb, connect the longitudinal fibers at the level of the TLPA, and TLPA itself with the deep transverse palmar ligament that runs between the volar plates of all MCP joints. On cross-section, the TLPA and the deep transverse ligament, together with the ligaments of Legueu and Juvara, form nine boxes, which on an alternating basis hold either the lumbrical muscle and NV bundles, or the flexor tendons of each ray. Much smaller vertical fibers are dispersed throughout the palmar aponeurosis and anchor it to the overlying skin.

The digital fascial structures relevant to Dupuytren disease bear the names of Cleland and Grayson. Their detailed anatomical description has undergone significant changes over time and drawings depicting the exact course of their fibers have been conflicting. Recently their microanatomy has been redefined (Fig. 55.2).[7,8] Grayson ligament as it was described in 1941 appears to be the most condensed part of a trabecular network of fibers that is located volar to the NV bundle and consists of fibers that originate from the outside of the flexor tendon sheet and end in the deep dermis on the contralateral side of the finger. The fibers have an inverted V-shaped orientation, which becomes less pointed during flexion. Since the trabecular network encompasses



• **Fig. 55.1** Schematic drawing of the relevant palmar fascial structures at the palmo-digital junction. The pretendinous fibers can be seen to divide in three layers. Layer 2, the spiral band, courses around the neurovascular bundle. *a*, pretendinous band (PT); *b*, Transverse ligament of the palmar aponeurosis (TLPA); *c*, natatory ligament (NL); *d*, continuation of the spiral band as it extends into the digit. *1*, layer 1; *2*, layer 2 or spiral band; *3*, layer 3. (From McGrouther DA. The palm. In: Flint MH, McGrouther DA, McFarlane DA. *Dupuytren Disease: Biology and Treatment*. Edinburgh: Churchill Livingstone; 1990: Fig. 12.3.)



• **Fig. 55.2** Schematic cross-section through the distal proximal phalanx, showing Cleland ligament and Grayson trabecular network. (From Zwanenburg RL, McGrouther DA, Werker PMN. Grayson ligament: a revised description of its anatomy and function. *J Hand Surg Am.* 2019:44(4):341e1–341e6:Fig. 4.)

fat lobules, it seems to accommodate the adaptation of the skin to objects held in the flexed finger hands.

Regarding Cleland ligaments, they have been found to be oriented in pairs located on each side and originating at the level of the proximal interphalangeal (PIP) and distal interphalangeal (DIP) joints, and from there they course proximally and distally. Three layers have been distinguished: the most volar layer emerges from the fibers of the C1 and C3 pulleys of the flexor tendon sheet, the middle layer from the volar plate, and the most dorsal layer, which actually is a double layer, circumvents the extensor apparatus. After joining just lateral from the volar plate, they fan out proximally and distally, and run dorsal to the NV bundles.

At the place where the hypothenar muscles pass into the little finger there is a blending of fibers that run in all three directions, and they all seem to play a role in Dupuytren disease. At the thenar and in the first webspace there is also a complex three-dimensional network of bands, which may also play a part in the disease.

Band and Cords

There is consensus about the role of most of these fascial structures in the disease (Table 55.1). If a well-defined band becomes affected by disease, it is no longer called "band" but becomes "cord."

At present it is believed that the transverse ligament of the palmar aponeurosis (TLPA) is not affected by DD. Because of this, and since this structure lies palmar to the NV bundles but dorsal to the pretendinous and prelumbrical cords, most surgeons agree that it can be left in situ, and as such serves as a reference point during secondary surgery. Distal to TLPA, however, the dissection always needs to be performed with great care as the NV bundle may be displaced by a spiral cord medially and volarly and may become so intimately related to it that only the experienced eye can discern it. Fat present between a cord and the skin in between TLPA and NT, should raise a high suspicion of a spiral cord.[9] In 2010, Hettiaratchy et al described a number of cases in which a *double* spiral around the digital nerve was encountered, and in these cases, at least one of the spirals was found in the finger.[4] McFarlane tried to simplify the often complex phenotype of the disease in the finger by defining three anatomical patterns of disease: the central cord, the lateral cord, and the spiral cord.[6] Further work is required to be able to explain all these findings, including those of Hettiaratchy et al, during surgery.

Etiology

The etiology of DD has still not been fully clarified, but it is clear that an interplay of genetic and environmental factors sets the stage for the emergence of the disease. Additionally, the disease occurs more frequently when other diseases such as diabetes mellitus, liver disease or epilepsy needing long-term barbiturate use are present.[10] In addition, there is an association between high levels of exposure to manual labor and vibration (metanalysis odds ratio (OR) for manual work: 2.0 [1.6;2.6] and for vibration exposure: 2.9 [1.4;6.1]) and the development of Dupuytren disease in certain cases.[4] Vibration exposure may also be the reason that DD was found more often in field hockey players.[11]

As for the genetic basis for the disease, a number of older population studies suggesting an autosomal dominant trait with variable penetrance have been set aside by recent Genome Wide Association Studies (GWAS). Using this technology first Dolmans et al and later Ng et al have shown that DD is a polygenetic disease.[12,13] It has been calculated that the sibling recurrence risk for DD is 4.5. From a recent Danish study in twins it was concluded that the heritability of Dupuytren's disease was approximately 80%, showing that genetic factors play a major role in the development of DD.[14]

Pathophysiology and Histology

The cells that have a key role in DD and deposit the superfluous extracellular matrix proteins are called myofibroblasts. They have contractile properties and express α-smooth muscle actin that is known from smooth muscles cells of vascular origin.[15] Much basic research is being devoted to this cell type in DD and it is clear now that myofibroblasts derived from DD nodules exhibit an abnormal response to mechanical tension[4]: they pull back harder than control fibroblast when lattices in which they have been seeded are put under tension. Contracture formation in DD seems to start with fixation of extended myofibroblasts to their extracellular matrix (ECM) followed by their active contraction. The shortened situation is thereafter fixated by the secretion of collagen type I and III and other ECM molecules. The collagen acts to stabilize the contracture, allowing the myofibroblast to relax again and repeat the cycle.[4] Recently, researchers also revealed an influence of adipocytes and macrophages on myofibroblast behavior in laboratory settings.[4,16]

In this respect the classic work of Luck in 1959 and the newer work of Lam et al in 2010 still has some relevance.[4] Luck analyzed the histopathology of Dupuytren disease and proposed a quite artificial subdivision in three phases and Lam analyzed the changes in collagen content over time:

1. During the proliferating phase an abundance of disorganized cells are found in nodules. In this phase Lam et al found that over 35% of the collagen that is deposited is of type III.
2. During the involutional phase the number of cells declines but alignment along lines of stress becomes obvious. The amount of collagen type III diminishes (20%–35%), whereas the amount of type I collagen increases.
3. In the residual phase the pathology resembles a scar and is hypocellular and consists of less than 20% of collagen type III.

The relevance of the presence of nodules with an abundance of proliferating cells is that it has been found to be a predictor for early recurrence.[4] It is, however, good to realize

TABLE 55.1 Various Fascial Structures in Palm and in Fingers of Interest in Dupuytren Disease

Anatomical Structure	Name if Affected by DD	Clinical Relevance
Fascial Structures in the Palm		
Pretendinous band (PTB), prelumbrical band (PLB)	Pretendinous cord (PTC), prelumbrical cord (PLC)	Situated immediately beneath the skin in the palm. Responsible for earliest signs of disease in most patients. Divides in three layers distal to transverse ligament of palmar aponeurosis
Layer 1 of PTB	PTC in palm, central cord in finger	Situated immediately beneath the skin, distal to line joining proximal and distal palm crease. May cause MCP joint and PIP joint contracture. Does not displace NV bundle
Layer 2 of PTB (spiral band)	Spiral cord	Contracture causes displacement of NB bundle medially and palmarly. May cause MCP joint contracture. Warning sign: Short–Watson sign[9]
Layer 3 of PTB	Vertical cord	Dives deep into the hand on both sides of MCP joint. May cause painful triggering
Transverse ligament of palmar aponeurosis (TLPA)	–	Runs along line joining proximal and distal palmar crease, deep to PTB/PLB. Not affected by DD. Can be left behind during fasciectomy. Will facilitate subsequent surgery when left intact
Ligaments of Legueu and Juvara	–	Connect TLPA to deep transverse ligament
Natatory ligament (NTL)	Natatory cord	Situated immediately beneath the skin and superficial to NB bundle. May cause web contracture
Proximal/distal commissural band	Proximal/distal commissural cord	Proximal band is extension of TLPA; distal band is extension of NTL. Situated immediately beneath the skin in the first web; may cause first web contracture
Abductor digiti minimi fascia	Abductor digiti minimi cord (ADMC)	Forms Y-shape together with PTB and ulnar NV bundle can always be found proximal to junction. ADMC may have multiple levels
Deep transverse ligament (DTL)	–	Connects volar plates of MCP joint. Together with ligaments of Legueu and Juvara and TLPA forms nine boxes through which flexor tendons and lumbrical muscles and NV bundles pass
Fibers of Gosset	– / nodules in palm?	Dispersed over palmar aponeurosis. Anchor palmar skin to TLPA
Fascial Structures in the Digits		
Lateral digital sheet	Lateral digital cord	Situated immediately under the skin on each side of each finger; may displace NV bundle towards midline. May cause MCP joint and PIP joint contracture when involved together with spiral cord and Grayson's ligament inserting to A4 pulley. May also cause DIP joint contracture as lateral cord
Grayson's ligament	Central cord (CC)	Harbors nodules and cords at proximal phalanx. May cause PIP contracture
Cleland's ligament	Cleland cord	Not easily visualized, since situated behind NV bundle. May cause PIP and DIP joint contracture
Transverse retinacular ligament	–	Connects mid slip of the extensor apparatus at PIP joint to the lateral bands and the volar plate. Palmar portion may shorten in severe PIP joint contractures, preventing the lateral bands to slide back after contracture release
Oblique retinacular ligament (Landsmeer)	–	Connects volar plate of PIP joint to dorsal capsule of DIP joint. May shorten and cause boutonnière deformity

Abbreviations: see text.

that nodules and cords may occur simultaneously and that nodules may even be found within cords, and that therefore the prognostic value of histological analysis of Dupuytren tissue remains controversial today, as compared to clinical parameters for fibrosis diathesis.[17]

Clinical Assessment and Differential Diagnosis

The early signs of DD are subtle irregularities in the palm under the skin, which may be difficult to discern, even for specialists. Such nodules and skin pits suggest the diagnosis, but the differential diagnosis in that stage should include ganglia and inclusion cysts, occupational hyperkeratosis, callous formation, tenosynovitis, giant cell tumors, and epitheloid sarcoma or even metastatic disease.[4] Once contractures emerge, the diagnosis is usually clear, although one may confuse DD with burn scars, congenital conditions (such as camptodactyly), stuck trigger finger, tendon bowstringing after pulley rupture as in rock climbers, tendon adhesions following infection or repair, tendon imbalance (as in sagittal band rupture), intrinsic joint contractures, CRPS 1 and cerebral or psychogenic spasticity.

The speed at which the disease progresses from nodules to cords to contractures has been subject of research by Lanting and Broekstra, who followed more than 250 people with early DD for 20 months and found that 75% of the participants had either stable disease or showed regression. Regression was correlated with a smaller surface area of pathology as projected on the skin.[18]

Notwithstanding this, once cords have formed, contracture formation is more likely to follow an exponential course than a linear one. Cords in the fingers can be central, and/or on either side and may be short, or extend from the palm to beyond the DIP joint. They can cause extension deficits of any finger joint, although DIP joint contracture is rare. More often, a longstanding PIP joint flexion position leads to an attenuation of the central slip, resulting in a proximal migration of the extensor apparatus, forcing the DIP joint into hyperextension and thereby causing a boutonnière deformity of the affected finger. DD often affects both hands, but often in dissimilar phases.

Grading Systems

The most practical grading systems for research purposes are those of Iselin, and Tubiana and Michon (Table 55.2).[4] Iselin's staging system is very practical for quick scoring such as during prevalence studies. Tubiana's system is more sophisticated and the modification suggested by Tubiana in 1986 makes the system relatively complex, hampering its widespread application. The downside of this system is that progression into a higher stage may take 5–40 degrees and is therefore not linear, but stepped. Therefore, for follow-up studies it is better to register and report the active or passive extension deficit (AED or PED) by joint and its sum by ray (TAED/TPED).

Management Principles, Operative and Nonoperative Options, and their Outcome

At present, both surgical and nonsurgical treatment options are available for the management of DD. Since the first reported fasciotomy in 1821 by Cooper, the pendulum of surgical treatment has swung from open fasciotomy (the demonstration of which made Baron Dupuytren famous),

TABLE 55.2 Grading Systems for Dupuytren Disease: Every Ray is Given a Stage Number

Described by	Stage	Meaning
Iselin	1	DD nodules and cords without contracture
	2	MCP joint contractures
	3	MCP joint and PIP joint contracture
	4	Boutonnière deformity with MCP and PIP joint contracture and DIP joint hyperextension
Tubiana	0	No signs of Dupuytren disease
	N	Nodules only. No contracture
	I	Total passive extension deficit (TPED) smaller than 45 degrees
	II	TPED between 46 and 90 degrees
	III	TPED between 91and 35 degrees
	IV	TPED between 136 and 180 degrees

Abbreviations: see text.

to radical surgery in an – unsuccessful – attempt to prevent extension and recurrence, and then back to minimally invasive percutaneous needle fasciotomy. In between the extremes of the pendulum's swing, treatments of intermediate aggressiveness such as selective or limited fasciectomy of pathology only, segmental fasciectomy, a procedure in which only small segments of cords are removed, and dermofasciectomy, the excision of both diseased fascia and skin and replacement of skin by skin grafting, have been promoted. In addition to all this, and still ongoing, there is research into the optimization of fasciectomy with interposition materials and a potential role of disease control with adjuvant peri-interventional pharmacotherapy with substances such as fluorouracil or tamoxifen to improve surgical outcome and reduce recurrence risk. The nonoperative treatments include injection therapy of nodules with steroids, or cords with collagenase and radiotherapy.

In the comparison of these treatment strategies, a number of aspects need to be addressed. These include: how the method manages (if at all) affected and adjacent skin, fascia, and the joints; the indication for and best timing of the treatment; specific treatment risks and complications; aftercare; immediate outcome (efficacy) and time of reconvalescence; late outcome (including its definition), also named durability, rate of recurrence, and treatment options for recurrences. The discussion will start with the description of each treatment, its short-term outcome and complications.

Operative Treatments

If surgery is considered, the skin, the fascia, and the affected joints should each be addressed.

Skin Management

When there is no or only limited shortage of skin, and the skin needs to be opened, a longitudinal incision from the distal palm into finger, a Bruner type incision, or a transverse incision at the level of TLPA and at all affected joint creases or a combination of these can be used. For segmental fasciectomy (SF), small C-shaped incisions are used.

Transverse incisions, especially in the palm, can be left open to heal secondarily, as long as not too big areas of bare tendon are exposed. To gain extra length for closure in the fingers, Z-plasties can be used to lengthen longitudinal incisions, and YV-plasties to lengthen zig-zg insicions. Z-plasties are best planned between the proximal finger crease and the PIP joint crease, since at that level there is usually the greatest abundance of skin. Attention should be paid not to transpose the flaps too far and stitch the flaps so tight that they hamper flexion.

If skin transposition is not sufficient to close a defect, or if the skin has been removed, it can be augmented or replaced using skin grafts. Skin grafts have also been advocated as firebreaks and in some hands proved very successful in the prevention of recurrence.[19] Full-thickness skin grafts (FTSGs) are usually recommended because they are more durable and undergo less secondary contracture than split-thickness skin grafts (STSGs). FTSGs are usually taken from the ipsilateral extremity, or the groin. Donor sites are closed primarily but leave scars, one of the downsides of this treatment. Others are: increased duration of the procedure, prolonged rehabilitation period, and increased risk for complications: a graft may not take, extending the reconvalescence period.

Apart from grafts, a great variety of local (homo- or heterodigital), regional flaps have been reported to manage skin shortage and even free flaps were used in severe diathesis cases to prevent recurrence with very good long-term results in one case report.[4]

Fascia Management: Transsection, Partial Excision, Total Excision

Of the surgical treatment modalities, radical fasciectomy (RF) is only listed here for completeness. It involved the attempt at complete removal of all palmar fascia of the hand and fingers with the intention to cure the patient. It was abandoned because this latter goal was usually not achieved and because of a high complication rate, particularly hematoma formation, pain, stiffness, cold intolerance, and skin slough.

Due to the association of these complications with extensive surgery, selective or limited fasciectomy (LF) still is the most commonly performed surgical procedure for DD. Only the diseased fascia is removed, usually with a small margin of normal fascia. The generally accepted indication for treatment is a painful nodule that does not respond to conservative measures or a progressive flexion contracture of MCP joint of 20–30 degrees or any PIP joint contracture. A PIP joint contracture of more than 60 degrees is at higher risk for both incomplete correction and early recurrence. It should therefore be addressed without delay.

SF is a less invasive variant of LF in which only 1-cm pieces of diseased tissue at strategic places are removed.[4] Open fasciotomy, the method employed by Dupuytren himself, is also still employed by some: through transverse incisions, cords responsible for contractures are identified, isolated from the NV bundles and divided.

All above-mentioned procedures for the management of the fascia are usually employed under wide-awake-local-anesthesia-no-tourniquet (WLANT), regional or general anesthesia. This is one of the major differences with needle aponeurotomy (NA), also named percutaneous needle fasciotomy (PNF), which is one of the least invasive surgical procedures for DD treatment. During PNF, cords are *percutaneously* divided with a fine (27–28G) needle under local anesthesia. PNF may be performed at multiple levels along the cords during the same session.[20] Since cords are insensate, only very small aliquots of intradermal local anesthesia are needed at the site of skin puncture to allow the procedure. By doing this, nerve conduction is maintained, enabling the patient to warn the surgeon if the needle touches a nerve.

Combined Removal of Skin and Fascia

Dermofasciectomy (DF) is the removal of both skin and underlying pathology. Most authors apply it in cases with

aggressive disease with clearly affected skin and (early) recurrence, especially in young patients. Logan advocates the removal of all palmar skin and pathology from the distal palm all the way to the DIP joint crease, leaving the flexor tendon sheet and NV bundles behind. The wound is subsequently covered using a full-thickness skin graft and the hand is immobilized using a cast for a week to allow the graft to take.[19] The skin graft in general adapts well, becomes sturdy, and regains sensibility, which is similar to that of thinly elevated skin flaps in LF.

PIP Joint Management

Removal of the DD cords can virtually always correct MCP joint contractures. Using PNF some contractures may persist, since they are caused by cords that run behind the NV bundles and cannot easily be reached without damaging the NV bundles. PIP joint contractures on the other hand can be more difficult to redress by removal of cords only, since in contrast to the MCP joint the PIP joint capsule itself may be affected by DD. One approach for persistent PIP joint contractures at the end of cord removal is sequential transverse division of the flexor tendon sheath, the check rein ligaments of the palmar plate, and the release of the accessory collateral ligaments, until full release of the contracture is accomplished.[4] Alternatively, and with similar results, intraoperative gentle manipulation can be applied. In fact, this is what probably takes place during continuous traction via an external fixator.

Attenuation of the central slip of the extensor apparatus may also be a significant factor in the inability to preserve correction of PIP joint contractures greater than 60 degrees.

Postoperative Management

After PNF, a very small dressing for just one day suffices. Following LF and SF, the treated hand is usually put in a soft bulky dressing for a few days to a week, sometimes reinforced by a splint, which is standard after DF and skin grafting. Following graft take and suture removal, patients begin flexion and extension exercises and this process is often supervised by hand therapists.

Early Outcome, Complications, and Reconvalescence Time After Surgery

With LF an average reduction of total passive extension deficit (TPED) of 79% at 6 weeks postoperatively has been reported. Results were best at the MCP joint (87% reduction of PED) and less good at the PIP joint (49% reduction of PED), which is a common finding with any surgical technique applied.

Treatment-specific complications of surgery are common.[4] The cumulative complication rate for LF has been found to be 19% and even higher in DF and RF. Skin slough can usually be treated conservatively. Hematomas should be evacuated before settling and causing fibrosis and early recurrence. Joint stiffness is most difficult to treat and functionally sometimes worse than the original flexion deformity. Nerve injury occurs in approximately 1% of primary cases and should be handled by direct repair, if feasible. Surgery may also cause injury to the digital arteries, the incidence of which is most likely underreported. In a worst-case scenario, especially after repeated surgery, vascular injury may result in gangrene of the operated finger, necessitating partial or complete amputation of a finger. The mean recovery period to normal hand use after surgery is for LF on average 6–12 weeks and for DF 2 weeks longer. During this period, the achieved functional result measured at 1 week will gradually improve.[21]

Overall, PNF is similarly effective than the more invasive surgical procedures for MCP joint, but less so for PIP joint contractures. Early outcome of PNF is therefore similar as for LF when the initial TPED is less than 90 degrees.[4] Complications are limited to skin tears and the risk of damaging nerves or tendons is far less than 1%. Skin fissures are more likely to occur with adherent skin, although one can try to prevent this by releasing the skin from the cord. Since they heal without leaving a trace, they usually do not bother the patient. The cumulative risk of serious complication of PNF is much less than that of the more invasive treatments and this is one of the reasons for its popularity.

Medicinal Treatment as Adjunct to Surgery: Interposition Materials after SF

Since DD is a disease wherein myofibroblast activation plays a key role, any pharmaceutical influence of this process may alter or even control disease progression. Several studies have assessed possible future options of disease control in association with surgery. 5-Fluorouracil in vitro was able to delay fibroblast proliferation. Unfortunately, systemic treatment with 5-fluorouracil in a randomized controlled trial (RCT) proved ineffective.[4]

Short-term surgical outcome improvement was achieved with neoadjuvant highly dosed tamoxifen, but long-term effects were lost after cessation of the drug.[19]

Nonoperative Treatments: Steroid and Collagenase Injections, Radiotherapy, Splinting

Treatment in early DD (Tuniana stage N) is rarely indicated. DD nodules may be painful but no unequivocal effective treatment for this is available. Patients may be advised to wear padded (biking) gloves to disperse pressure and limit pain during power grip. Steroid injection is also advocated by some to relieve pain and discomfort, and was found to reduce the size of 40% of the treated nodules after 6 months and in 56% of cases after 5 years.[22]

Collagenase injection is a popular nonoperative treatment modality for contractures, although not available in all countries. The technique was developed by Hurst and Badalamente and is a classic example of a "bench-to-bed"

development of a new therapy.[23] It degrades the collagen in cords to obtain an enzymatically induced fasciotomy effect. Two types of collagenase derived from the microorganism *Clostridium histolyticum* are injected. The action of these enzymes is limited to types I and III collagen, present in cords but also in pulleys and tendons, so injection with care is needed. Since digital nerves and arteries primarily contain type II and IV collagen, they are not at risk for enzymatic damage. The collagenase is strategically injected into a cord causing a minimum of 20 degrees contracture, to weaken and rupture it by manipulation afterwards. This manipulation can be painful and is most often performed under local anesthesia. If the obtained result is not satisfactory, the treatment may be repeated after 30 days. Recently, successful results of simultaneous multiple injections in multiple cords using a double enzyme dose have been reported.[24] In 77% of the MCP joints and in 40% of the PIP joints, collagenase injection[4] released the contracture to 0–5 degrees. Serious adverse events (SAEs) such as tendon ruptures and complex regional pain syndrome are rare complications, but adverse events (AEs) such as swelling, hematoma, and pain occur almost always (97% of cases) but resolve spontaneously.

Halfway through the 20th century, the first report on radiotherapy (RTX) emerged as a possible treatment modality for early DD. It is based on the idea of possible ionizing radiation-induced DNA damage and consequent apoptosis of rapidly growing cells.[19] Early reports were ambiguous. This changed in subsequent series, but available evidence on the efficacy of radiotherapy in DD remains weak since all studies were performed in early and mild DD and only retrospective cohort analysis is reported to emphasize a possible reduction in disease progression.[19] High-quality RCTs are missing to substantiate the benefit of RTX and the risks in DD are unclear. Next to its mild local toxicity, an absolute 0.02% risk increase for malignancies is estimated.[25] Lastly, late radiation fibrosis, a known side-effect of radiotherapy, remains an uncertain long-term risk whereof the patient also needs to be informed before considering this option.

Therapeutic splinting in DD is controversial.[26] With intensive splinting (traction or compression orthotic devices are available), correction of contractures can be achieved without surgery. Nevertheless, the splinting is intense and not always tolerated by the patient. Moreover, after successful corrective splinting, recurrence of contractures is expected, unless long-term (night-)splinting is continued.

Long-Term Outcome

Definition of Recurrence

When fasciectomy was the predominant treatment option, recurrence was defined as the occurrence of new fibromatosis in previously cleared areas and extension as the occurrence of fibromatosis in new areas. Gradually and powered by other treatment regimens, a wide disparity in definitions came into use, hampering the comparison of case studies.[27]

Durability of Operative Treatments

An RCT comparing LF and PNF with a follow-up duration of 5 years showed a recurrence rate following LF of 21% using a definition of any increase of TPED of over 30 degrees relative to the result at 6 weeks postop.[21] Others, using the LeClercq definition, have published recurrence figures of up to 73%, 7 years after LF.[4.]

For the long-term outcome of skin grafting in DD, the work of Ketchum is instructive.[19] He found no recurrent disease under the skin grafts in 36 hands of 24 patients an average of 4 years after fasciectomy and "firebreak" skin grafting. The incidence of extension of disease outside the grafts was 8%. It is, however, critical to distinguish the above technique of simple intercalated "firebreak" skin grafting and dermofasciectomy and skin grafting. Armstrong et al reported a recurrence rate under the grafts with the latter technique of 8.4% of 143 treated rays at 6 years.[4] The recurrence rates of SF appear similar to those of LF.[4]

PNF recurrence rates are relatively high compared to more aggressive treatment modalities. The 5- year recurrence rates of PNF in the earlier-mentioned RCT of LF versus PNF were 85%.[21] Selles et al have failed to reduce this high recurrence rate by adding autografted fat by means of lipofilling to cords that had been extensively divided.[28]

Degreef et al have demonstrated a delay in recurrence following SF by placing cellulose implants in the gap created by segmental fasciectomy.[19] Long-term results of OF are scarce, but recurrence rates of 41% after an average of 5.6 years' follow-up seem to match outcome reports of LF.[4]

Long-Term Outcome of Nonoperative Treatments

Ketchum also investigated the durability of triamcinolone injections. Fifty percent of his patients did experience reactivation of disease in the nodules 1–3 years after the last injection, necessitating one or more injections.[4]

The recurrence rate in collagenase studies is defined as loss of more than 20 degrees of PED in joints that had initially complete correction. Because this definition excludes recurrence in joints that were not initially fully corrected (and have higher recurrence rates[4]), it skews results favorably and makes comparison to studies in which other definitions of recurrence are used difficult. Using this definition of recurrence, recurrence following collagenase was 47% after 5 years.[29]

The reported progression rates of radiotherapy are as follows: After a mean of 10 years, 87% of the patients that had been treated with Tubiana Stage N and 70% of the patients treated while in Tubiana Stage N/I remained stable or regressed. In more advanced stages, the rate of disease progression increased to 62% (Stage I) or 86% (Stage II). Sixty-six percent of the patients showed a long-term

relief of initially reported side effects (i.e., burning sensations, itching and scratching, pressure and tension).[4] The basic issue that needs further study, however, is the time versus progression relation in Dupuytren disease. This relation seems more likely exponential than linear and since radiotherapy has only been found to be effective in early stages of the disease, it is unclear what actually is being accomplished.

Efficacy and Durability of Surgical Methods in Comparative Studies

Recently, a number of comparative studies have appeared that shed more light on the efficacy and durability of the various surgical treatments. Two approaches can be distinguished: one in which an RCT design was chosen in which consecutive participants were randomly assigned to a treatment, and one in which surgeons together with their patients chose what they thought was the best treatment at that moment, while what later statistical methods called "propensity score matching" was applied to create groups with comparable age, sex, diathesis, and other characteristics. Both designs have their specific advantages and disadvantages: RCTs usually have difficulties recruiting participants and therefore take relatively long to execute; propensity score matching removes all participants that do not match on the previously decided items and may inadvertently filter out cases that would have influenced ultimate comparison.

Representatives of the RCT design are the Scandinavian studies from Strömberg, Skov et al and Scherman et al, in which the efficacy and durability of PNF was compared to that of collagenase.[30–32] Statistical analyses of their data revealed that the short-term as well as the long-term results of both treatments are not significantly different. Another example is the earlier cited RCT of the Rotterdam group, in which they compared LF with extensive percutaneous needle fasciotomy in combination with lipofilling (PALF). Although the one-year results were promising, since PALF results were still not statistically significantly different from LF, the durability of PALF was clearly less good than that of LF and in our view very similar to those of PNF studies that did not use lipofilling as an adjunctive (although not statistically analyzed).[28]

Using the propensity matching approach, the Rotterdam group has found no differences in efficacy between PNF and collagenase *Clostridium histolyticum* (CCH), and PNF and LF.[33]

Treatment of Recurrence

Evidence for the best treatment for recurrence is scarce. What is known is that PNF can also be used safely for the treatment of recurrences and is just as effective as during primary PNF, which makes it an even more interesting treatment modality: at least it postpones more aggressive treatment to a higher age, where recurrence may occur after a longer time frame.[21] Collagenase can also be used safely in recurrences.[4]

Surgery following PNF is not more difficult than virgin surgery. No unequivocal opinion exists as to surgery after treatment with collagenase.[4]

The role of radiotherapy for recurrent disease is yet unclear.

In repeated limited fasciectomy there is a greater risk of complications,[4] most likely because the anatomy is severely altered following the first LF and it is much more difficult to identify and preserve the NV bundles. For this reason, the number of LF procedures should be limited to the minimum, and for the treatment of early recurrence DF and skin grafting has our preference.

Rehabilitation

Splinting and hand therapy are commonly advised after surgery for DD and a great variety of protocols is being employed.[4] Evidence for the use of either of them is lacking, however.[4] Compression therapy does seem to be beneficial to reduce edema and enhance functional recovery. Some are of the opinion that only patients with rapidly reoccurring extension deficits may benefit from night splints, but research is missing that can substantiate this.

Conclusions/Personal View

Dupuytren disease is a chronic disease with variable penetrance, phenotype, and disease course for which at present a cure is lacking. Since the turn of the century the body of knowledge on the basics of the disease, especially on genetic and molecular level, has increased substantially. Additionally, new treatment modalities have emerged and gradually high-quality trials are emerging in the literature that compare treatment regimens. Gradually, an evidence-based treatment algorithm can be drawn. Nonetheless, no treatment at present is universally the best for every patient with DD.

Following counselling the patient about all surgical and nonsurgical treatment modalities, we advise him or her primarily based on: (1) age, (2) progressiveness, (3) extent of disease, and (4) diathesis characteristics. In the most extreme forms, a young (<40 years) patient with aggressive disease with PIP contractures will be warned for early recurrence with minimally invasive (PNF of collagenase) and standard technique (LF) and is offered DF and skin grafting. In patients of over 75 years of age with contracture and mild progression, PNF or collagenase will be advised, based on the work of van Rijssen et al and Peimer et al.[21,29]

All others are offered either PNF of limited fasciectomy, stating that PNF is less invasive and thus gives less trouble after treatment on the short run, but is hampered by earlier recurrence, that can be treated again with PNF, while LF may have a more cumbersome reconvalescence but has better durability.[21,34] Although PNF can often be repeated,[34] at some point it is not effective any more and maybe there is a role for CCH there.

For recurrence in general, the choice for the best treatment is even more difficult. As said before, PNF can be effectively applied again for recurrences.[34] Only if the fibromatosis is very adherent to the skin, it may become difficult to achieve an acceptable result without skin rupture. If the patients accept skin rupture and a small flap or graft to close the defect, it can be offered. When PNF is no longer possible or desired, LF is the next step and DF for very early recurrences. Collagenase also has a role in the treatment of recurrence, maybe especially in those cases where PNF is no longer an option, because of diffuse disease and maybe even in recurrences following LF, but that is yet to be proven.

Given the increasing body of evidence that splinting does not improve the result of surgery, we advise splints only for all those with extensive disease, and primarily aim to help regain flexion as soon as possible, but do continue to send patients to hand therapists for compression therapy and early active mobilization.

References

1. Lanting R, Broekstra DC, Werker PM, et al. A systematic review and meta-analysis on the prevalence of Dupuytren disease in the general population of Western countries. *Plast Reconstr Surg*. 2014;133(3):593–603.
2. Wilburn J, McKenna SP, Perry-Hinsley D, et al. The impact of Dupuytren disease on patient activity and quality of life. *J Hand Surg Am*. 2013;38(6):1209–1214.
3. Rodrigues JN, Zhang W, Scammell BE, et al. Recovery, responsiveness and interpretability of patient-reported outcome measures after surgery for Dupuytren's disease. *J Hand Surg Eur*. 2017;42(3):301–309.
4. Werker PMN. Dupuytren disease. In: Farhadieh RD, Bulstrode NW, Cugno S, eds. *Plastic and Reconstructive Surgery: Approaches and Techniques*. Oxford: Wiley; 2015:838–849.
5. McGrouther DA. The microanatomy of Dupuytren's contracture. *Hand*. 1982;14(3):215–236.
6. McFarlane RM. Patterns of the diseased fascia in the fingers in Dupuytren's contracture: displacement of the neurovascular bundle. *Plast Reconstr Surg*. 1974;54(1):31–44.
7. Zwanenburg RL, Werker PM, McGrouther DA. The anatomy and function of Cleland's ligaments. *J Hand Surg Eur*. 2014;39(5):482–490.
8. Zwanenburg RL, McGrouther DA, Werker PMN. Grayson ligament: a revised description of its anatomy and function. *J Hand Surg Am*. 2019;44(4):341.
9. Short WH, Watson HK. Prediction of the spiral nerve in Dupuytren's contracture. *J Hand Surg Am*. 1982;7(1):84–86.
10. Broekstra DC, Molenkamp S, Groen H, et al. A systematic review and meta-analysis on the strength and consistency of the associations between Dupuytren disease and diabetes mellitus, liver disease and epilepsy. *Plast Reconstr Surg*. 2018;141(3):367e–379e.
11. Broekstra DC, van den Heuvel ER, Lanting R, et al. Dupuytren disease is highly prevalent in male field hockey players aged over 60 years. *Br J Sports Med*. 2018;52(20):1327–1331.
12. Dolmans GH, Werker PM, Hennies HC, et al. Wnt signaling and Dupuytren's disease. *N Engl J Med*. 2011;365(4):307–317.
13. Ng M, Thakkar D, Southam L, et al. A genome-wide association study of Dupuytren disease reveals 17 additional variants implicated in fibrosis. *Am J Hum Genet*. 2017;101(3):417–427.
14. Larsen S, Krogsgaard DG, Aagaard Larsen L, et al. Genetic and environmental influences in Dupuytren's disease: a study of 30,330 Danish twin pairs. *J Hand Surg Eur*. 2015;40(2):171–176.
15. Tomasek JJ, Gabbiani G, Hinz B, et al. Myofibroblasts and mechano-regulation of connective tissue remodelling. *Nat Rev Mol Cell Biol*. 2002;3(5):349–363.
16. Verjee LS, Verhoekx JS, Chan JK, et al. Unraveling the signaling pathways promoting fibrosis in Dupuytren's disease reveals TNF as a therapeutic target. *Proc Natl Acad Sci U S A*. 2013;110(10):E928–E937.
17. Degreef I, De Smet L, Sciot R, et al. Beta-catenin overexpression in Dupuytren's disease is unrelated to disease recurrence. *Clin Orthop Relat Res*. 2009;467(3):838–845.
18. Lanting R, van den Heuvel ER, Werker PM. Clusters in short-term disease course in participants with primary Dupuytren disease. *J Hand Surg Am*. 2016;41(3):354–361; quiz 361.
19. Werker PMN, Degreef I. Alternative and adjunctive treatments for Dupuytren disease. *Hand Clin*. 2018;34(3):367–375.
20. Eaton C. Percutaneous fasciotomy for Dupuytren's contracture. *J Hand Surg Am*. 2011;36(5):910–915.
21. van Rijssen AL, ter Linden H, Werker PM. Five-year results of a randomized clinical trial on treatment in Dupuytren's disease: percutaneous needle fasciotomy versus limited fasciectomy. *Plast Reconstr Surg*. 2012;129(2):469–477.
22. Yin CY, Yu HM, Wang JP, et al. Long-term follow-up of Dupuytren disease after injection of triamcinolone acetonide in Chinese patients in Taiwan. *J Hand Surg Eur*. 2017;42(7):678–682.
23. Hurst LC, Badalamente MA, Hentz VR, et al. Injectable collagenase *Clostridium histolyticum* for Dupuytren's contracture. *N Engl J Med*. 2009;361(10):968–979.
24. Gaston RG, Larsen SE, Pess GM, et al. The efficacy and safety of concurrent collagenase *Clostridium histolyticum* injections for 2 Dupuytren contractures in the same hand: a prospective, multicenter study. *J Hand Surg Am*. 2015;40(10):1963–1971.
25. Kadhum M, Smock E, Khan A, et al. Radiotherapy in Dupuytren's disease: a systematic review of the evidence. *J Hand Surg Eur*. 2017;42(7):689–692.
26. Brauns A, Van Nuffel M, De Smet L, et al. A clinical trial of tension and compression orthoses for Dupuytren contractures. *J Hand Ther*. 2017;30(3):253–261.
27. Werker PM, Pess GM, van Rijssen AL, et al. Correction of contracture and recurrence rates of Dupuytren contracture following invasive treatment: the importance of clear definitions. *J Hand Surg Am*. 2012;37(10):2095–2105. e7.
28. Selles RW, Zhou C, Kan HJ, et al. Percutaneous aponeurotomy and lipofilling versus limited fasciectomy for Dupuytren's contracture: 5-year results from a randomized clinical trial. *Plast Reconstr Surg*. 2018;142(6):1523–1531.
29. Peimer CA, Blazar P, Coleman S, et al. Dupuytren contracture recurrence following treatment with collagenase *Clostridium histolyticum* (CORDLESS [collagenase option for reduction of Dupuytren long-term Evaluation of safety study]): 5-year data. *J Hand Surg Am*. 2015;40(8):1597–1605.
30. Scherman P, Jenmalm P, Dahlin LB. One-year results of needle fasciotomy and collagenase injection in treatment of Dupuytren's contracture: a two-centre prospective randomized clinical trial. *J Hand Surg Eur*. 2016;41(6):577–582.

31. Skov ST, Bisgaard T, Sondergaard P, et al. Injectable collagenase versus percutaneous needle fasciotomy for Dupuytren contracture in proximal interphalangeal joints: a randomized controlled trial. *J Hand Surg Am*. 2017;42(5):321–328. e3.
32. Strömberg Joakim J. Percutaneous needle fasciotomy versus collagenase treatment for Dupuytren contracture: a randomized controlled trial with a two-year follow-up. *J Bone Joint Surg Am*. 2018;100(13):1079–1086.
33. Zhou C, Hovius SE, Slijper HP, et al. Collagenase *Clostridium histolyticum* versus limited fasciectomy for Dupuytren's contracture: outcomes from a multicenter propensity score matched study. *Plast Reconstr Surg*. 2015;136(1):87–97.
34. van Rijssen AL, Werker PM. Percutaneous needle fasciotomy for recurrent Dupuytren disease. *J Hand Surg Am*. 2012;37(9):1820–1823.