Extensive Percutaneous Aponeurotomy and Lipografting: A New Treatment for Dupuytren Disease

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Background: Surgical resection of Dupuytren contracture is fraught with morbidity and prolonged recovery. This article introduces a novel minimally invasive alternative for Dupuytren disease and its outcome.
Methods: The procedure consists of an extensive percutaneous aponeurotomy that completely disintegrates the cord and separates it from the dermis. Subsequently, the resultant loosened structure is grafted with autologous lipoaspirate. After 1 week of postoperative extension splinting, patients are allowed normal hand use and are advised to use night splints for 3 to 6 months. The authors treated and report on their experience with 91 patients (99 hands) operated on in Miami and Rotterdam; from 50 patients, the authors report on goniometry (average follow-up, 44 weeks).
Results: The contracture from the proximal interphalangeal joint improved significantly from 61 degrees to 27 degrees, and contracture from the metacarpophalangeal joint improved from 37 degrees to –5 degrees. Ninety-four percent of patients returned to normal use of the hand within 2 to 4 weeks and 95 percent were very satisfied with the result. No new scars were added, and a supple palmar fat pad was mostly restored. Complications were digital nerve injury in one patient, postoperative wound infection in one patient, and complex regional pain syndrome in four patients.
Conclusions: This new minimally invasive technique shortens recovery time, adds to the deficient subcutaneous fat, and leads to scarless supple skin. By its ability to treat multiple rays, it addresses the abnormality in the entire hand. The procedure is safe and effective, especially for primary cases. Currently, comparative prospective randomized studies are in process to fully determine its role in the treatment of Dupuytren contracture. (*Plast. Reconstr. Surg.* 128: 221, 2011.)
CLINICAL QUESTION/LEVEL OF EVIDENCE: Therapeutic, IV.

Dupuytren disease is a benign, progressive, fibroproliferative, chronic disorder that results in abnormal scar-like tissue in the palmar fascia of the hand. Extension to the digits causes progressive digital flexion contractures. Treatment of Dupuytren disease is mainly surgical. Limited fasciectomy and limited dermofasciectomy are the techniques used most.[1] Although excisional surgery seems to be the standard treatment, the procedure is fraught with a significant rate of complications.[1] However, the greatest drawback of surgery is the associated morbidity and the time required until return to normal use of the hand. This need for less morbidity and shorter recovery time opened the door for less invasive treatment alternatives.[2,3]

Collagenase injections are a less invasive treatment option that can significantly reduce flexion contractures. The drawback seems to be the inflammatory reaction caused by collagenase and its potential harm to tendons and surrounding tissues. The results are promising, but the treatment is not yet widely available, no long-term follow-up

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data are available,[4,5] and a comparison with other treatment alternatives is lacking. Radiotherapy is another less-invasive treatment alternative. However, radiotherapy has been administered only for early-stage Dupuytren disease.[6]

Percutaneous release of contracted cords by needle aponeurotomy only is also less invasive and is recognized to promote fast postoperative recovery.[7,8] However, a 65 percent recurrence rate after 32 months has been reported using the standard procedure, which consists of a few full-thickness cord cuts with a needle.[8]

Despite its great appeal to patients, our experience with percutaneous aponeurotomy was also disappointing because of the rapid recurrence of the contracture. Having found that fat grafting is beneficial in softening scars in other clinical conditions, one of the coauthors (R.K.K.) decided to combine fat grafting with a novel minimally invasive percutaneous release technique that is permissive to fat grafting. In this study, we describe this new surgical method of extensive percutaneous aponeurotomy combined with fat grafting and report our first results from a cohort of 50 patients.

PATIENTS AND METHODS

Patient Population

Over a 32-month period, extensive percutaneous aponeurotomy combined with lipofilling was performed on a total of 91 patients and 99 hands (eight bilateral, 69 men and 22 women) in Miami or Rotterdam. Patients were eligible for this procedure when the tabletop test was positive, regardless of whether the contraction was in the metacarpophalangeal or proximal interphalangeal joint. Thirteen patients suffered from recurrent Dupuytren disease and had previously been operated on using fasciectomy. A medical ethical approval was obtained for analysis of the clinical data used for this study (MEC-2010-283; Erasmus Medical Center, Rotterdam, The Netherlands).

As a part of the clinical routine, goniometry data were collected (in Rotterdam) and clinical photographs of the hands were taken (in Rotterdam and Miami). From a total of 52 patients, both preoperative and postoperative goniometry data of the metacarpophalangeal and proximal interphalangeal joints were recorded or could be measured from the clinical photographs.[9–11] Reasons for incomplete goniometry data where the inability or unwillingness of patients to come for follow-up (many patients, especially in Florida, live abroad). Also, a number of patients had died. Two of the 52 patients had a first web contracture and were left out of the analysis. From the 50 patients, 15 had a proximal interphalangeal joint contracture, 11 had a metacarpophalangeal joint contracture, and 24 had both a proximal interphalangeal joint and metacarpophalangeal joint contracture. The amount of contracture was transformed to the Tubiana grading system to establish the total amount of improvement per ray. Complications, satisfaction with the operation, gain in hand function, and amount of time to full recovery were scored, and we asked patients whether they would recommend the same procedure again.

Surgical Technique

Fat Harvesting

Before operating on the hand, the abdomen and ipsilateral flank are prepared and draped. Through two to three puncture sites with a 14-gauge hypodermic needle, we diffusely inject in the subcutaneous fat 500 to 600 ml of a tumescent solution containing 50 ml of 2% lidocaine and 1 ml of 1:1000 epinephrine per liter of physiologic solution. We then harvest the fat by manual liposuction using a 12-gauge (2.7-mm), 12-hole (1 × 2-mm), 25-cm-long cannula connected to a syringe pulling a steady 300-mmHg vacuum suction. To separate the graft from the serum and tumescent solution, the collected lipoaspirate is then allowed to settle on the side table while the extensive percutaneous aponeurotomy is performed.

Extensive Percutaneous Aponeurotomy

Under regional or general anesthesia, the extremity is tightly exsanguinated. This collapses the vessels into cord-like structures and minimizes damage from the needle. The digits are placed under maximal extension tension using a firm lead hand retractor (Fig. 1). Then, progressing in an orderly fashion from proximal to distal, multiple palmar puncture wounds are made with a needle-like, sharp-tipped, bevelled piercing instrument. Working along a wide area around the contracture, the palpable cords under tension are progressively and extensively severed through slight transverse oscillations at each puncture point. Tension is maintained by constantly extending the digits as the contracture progressively gives way. Residual restricting bands are localized by palpation and addressed in the same fashion. To maintain tension on the released area, we carefully avoid skipping to a distal site until the proximal site is fully released and soft (Fig. 1).

The differential cutting effect provided by the tension on the cords is crucial. Tight con-

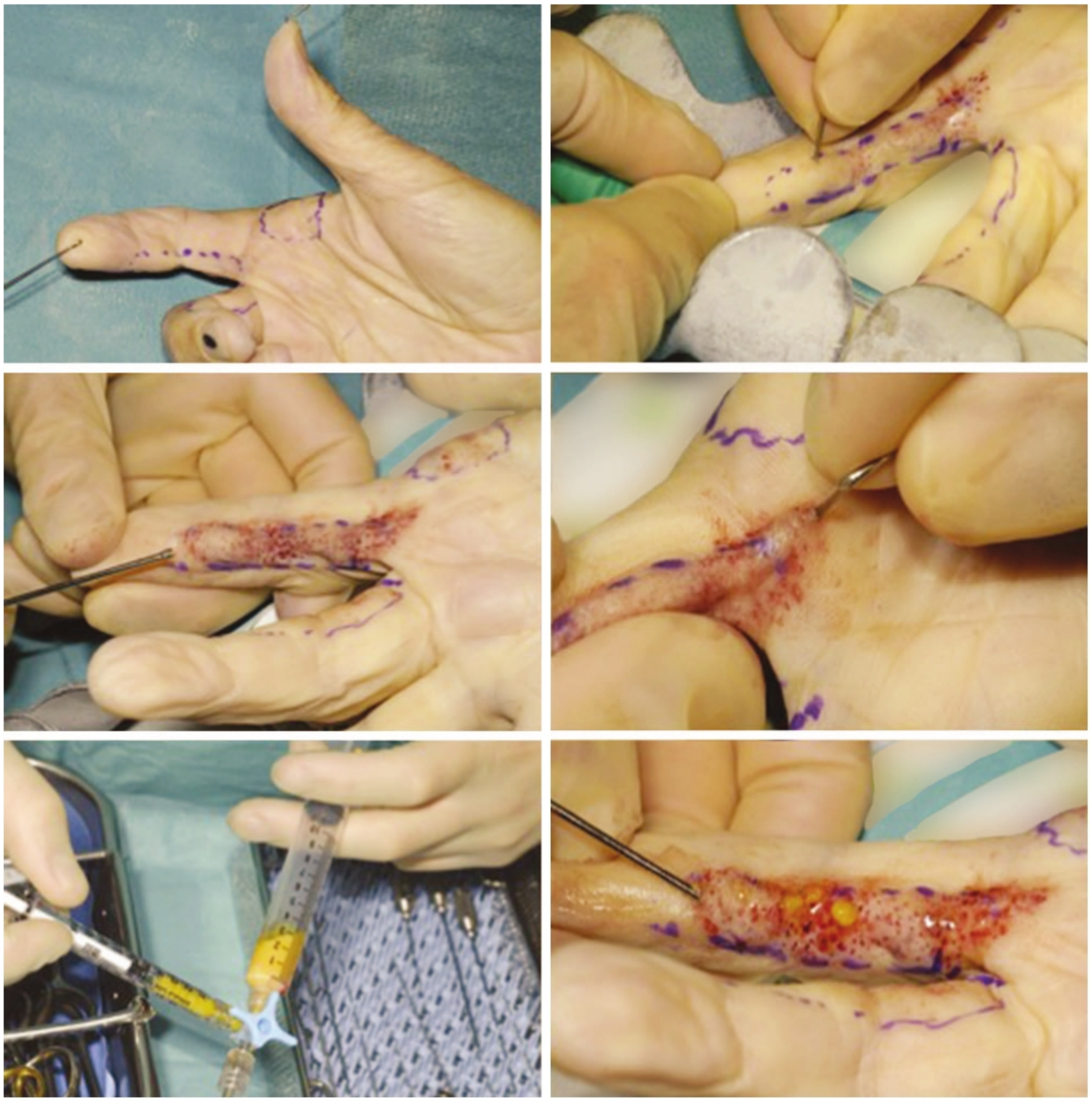

Fig. 1. Perioperative photographs showing the release of the cord and lipografting of a 63-year-old man with Dupuytren contracture. Note the multiple puncture sites. (Postoperative photographs are shown in Figure 3.)

stricting bands are most susceptible to be cut and torn by the small nicks, whereas the relatively looser neurovascular structures are spared. Because the internal collagen fibrous structure of the cord is a spiral-like weave, we need to sever the fibers only during their superficial course to inflict attrition damage to the entire weave and break it apart (Fig. 2).

The other important safety aspect is the depth of penetration that never exceeds 3 mm proximal to the transverse palmar crease and 2 mm in the distal palm and digits, because the digital nerve can be located dangerously superficial by a spiral cord. Depending on the severity of the contracture and the size and firmness of the nodules, this process often requires up to 50 puncture wounds per digital ray. Skin wrinkles and pits are released by severing the dermal attachments of the cord with a windshield wiper motion of the L-shaped cutting device (Dupuytome; Marina Medical, Sun-

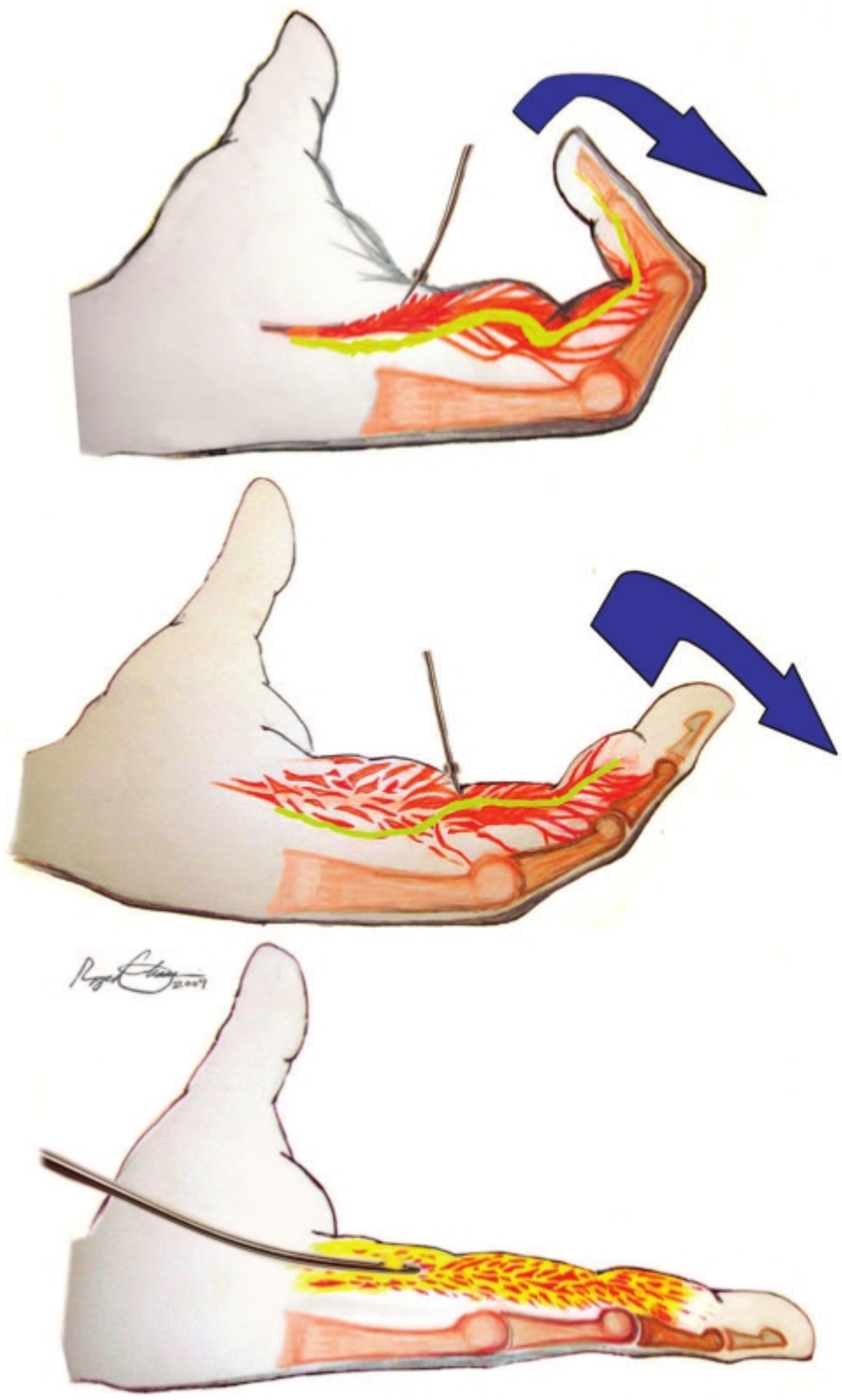

Fig. 2. Schematic representation of the intervention. Under maximal tension, the cord (*red*) is released from proximal to distal with multiple needle nicks. The digital nerve is *yellow*. After total release of the cord, a three-dimensional space is created in which fat can be injected.

rise, Fla.). The hand is ready for lipografting once the contracture is fully released, the skin is fully supple and separated from the cord, and the nodules are completely chopped and soft.

Lipografting

We inject the released and loosened fibrous structure with the supernatant of the lipoaspirate harvested from the abdomen or flanks. Through two to three needle entry sites in the palm and the digit, using a spatulated, single-sidehole, blunt-tip, 14-gauge cannula, the lipoaspirate graft is injected in multiple planes while the cannula is retracted along fanning tunnels. We usually inject a total of 10 ml per digital ray and expect some of it to escape through the needle release sites. The very dilute injectate provides a margin of safety against overgrafting. The tumescent effect of loose fat injection slightly inflates the palmar skin to reveal any residual tethering dermal bands that are then further released by the windshield wiper effect of the sharp-tipped Dupuytome.

Postoperative Care

A conforming dressing over the palmar skin that incorporates a plaster extension splint is kept for 5 to 7 days. After removal of the intraoperative dressing, the patient is allowed to return to his or her normal activities and advised to use a night extension splint for up to 20 weeks.

Statistical Analysis

For each patient, we elected to evaluate the most severely affected finger joint in the treated hand. We performed a paired *t* test on the range of motion to compare preoperative versus postoperative contracture of the proximal interphalangeal joint and the metacarpophalangeal joint. A Wilcoxon rank sum test was performed on the Tubiana grading group distribution.

RESULTS

Experiences during the Operation

We were able to perform the procedure with an operating room time similar to that for a fasciectomy. Operative time, including harvesting the grafts, was approximately 1 to 1.5 hours, depending on the amount of rays treated and was therefore comparable to conventional open fasciectomy times in our institutions.

We typically treated the entire palm of the hand and all the affected digital rays. Intraoperatively, we achieved full metacarpophalangeal joint extension in all patients. Full proximal interphalangeal joint extension was not always achieved, as severe contractures were mostly combined with capsular contractures. The cord could always be fully released. There were no skin deficiencies in the primary cases, even in the most severe contractures. In two recurrent cases, the old scar ripped open during the release, requiring a small flap and a graft.

Follow-Up Data

In the 50 patients from whom complete data were available, at a mean follow-up of 44 weeks, we found a significant flexion contracture correction from 61 degrees to 27 degrees for the proximal interphalangeal joint and from 37 degrees to –5 degrees for the metacarpophalangeal joint (Table 1). When we selected the proximal interphalangeal and metacarpophalangeal joints with a flex-

Table 1. Results of the 50 Patients for Whom Goniometric Data Were Available*

	No.	Preoperatively (degrees)	Postoperatively (degrees)	Improvement (degrees)	*p*	Follow-Up (wk)
PIP joint contracture	39	61.3 ± 24.5	26.7 ± 21.7	34.6 (56.4%)	<0.001	43.8
MP joint contracture	35	36.5 ± 18.9	–5.1 ± 8.2	41.6 (114.0%)	<0.001	42.2
PIP joint contracture ≥45 degrees	32	69.8 ± 17.2	29.4 ± 21.3	40.3 (57.7%)	<0.001	43.8
MP joint contracture ≥45 degrees	15	54.3 ± 8.9	–3.6 ± 6.5	57.9 (106.6%)	<0.001	44.3

PIP, proximal interphalangeal; MP, metacarpophalangeal.
*Extension deficit is shown in degrees. The fourth column shows the improvement of extension as a percentage. Follow-up is in weeks after surgery. Results are presented separately for patients with a relatively mild joint contracture (<45 degrees) and more severe joint contractures (≥45 degrees).

ion contracture of 45 degrees or more, the proximal interphalangeal joint improved significantly, from 70 degrees to 29 degrees, and the metacarpophalangeal joint improved significantly, from 54 degrees to –4 degrees. After surgery, 88 percent patients achieved Tubiana stage 1 (Table 2).

From experience during follow-up at the outpatient clinic, the most impressive finding was the restoration of a supple subcutaneous fat pad. The treated skin previously overlying the cords could be pinched off the deep fascia just like normal healthy palmar skin, which is rarely seen in the scarred hand following conventional fasciectomy (Fig. 3).

Clinical Experience: Time to Healing and Complications

Our clinical experience was that, except for four patients, in the total group of 91 patients, recovery and regained use of the hand for activities of daily living was acquired approximately 1 week after surgery. Return to either work or vocational activities was within 2 to 4 weeks. The four patients with a longer recovery time were all women with severe diathesis who had symptoms of complex regional pain syndrome, such as swelling, diminished function, and pain. Two of these patients had a history of complex regional pain syndrome in the other hand after open surgery for Dupuytren contracture and described their symptoms after the present procedure as less severe. There were no tendon injuries. There was one digital nerve injury (1.1 percent) and one postoperative wound infection (1.1 percent). Both complications occurred in hands that had previously been operated on. Except for one patient with wound infection, no delayed wound healing occurred.

Table 2. Distribution of Patients over the Different Tubiana Grades*

Tubiana Grade	Extension Deficit from Three Joints Combined (degrees)	No. of Patients per Group	
		Preoperatively	Postoperatively
1	0–45	9	44
2	45–90	26	6
3	90–135	14	0
4	≥135	1	0

*The Tubiana grade is defined based on the total extension deficit of the three finger joints combined. Postoperatively, almost all patients had a total extension deficit in the worst finger of less than 45 degrees according to the Tubiana grading system.

Patient Satisfaction

Of the 91 patients, 87 (95.6 percent) were very satisfied and would recommend the operation to family and friends. All 13 patients who had previous open surgery preferred this new procedure over their previous experience. The procedure left no visible scar, and led to subjective improvement in the feel and softness of the entire hand.

Three of the four patients with postoperative complex regional pain syndrome stated they would not choose this type of surgery again. Interestingly, the fourth would still recommend this same procedure to family and friends. Another patient was not satisfied, despite a positive outcome, because the other hand, which had been operated on, was straighter.

DISCUSSION

The most striking result during extensive percutaneous aponeurotomy was the release of the skin and cord even in fully flexed fingers. Operating time for extensive percutaneous aponeurotomy was comparable to limited fasciectomy or dermatofasciectomy. In our experience, the main gain of the minimally invasive technique is the short recovery time compared with the open surgical technique, especially if more rays are involved. However, a randomized controlled trial is needed to directly compare both techniques.

Open fasciectomy is the recognized standard treatment for Dupuytren contracture. The complication rate of 18 to 29 percent,[1] the recurrence rate of 27 to 70 percent after 5 years,[10,11] and the

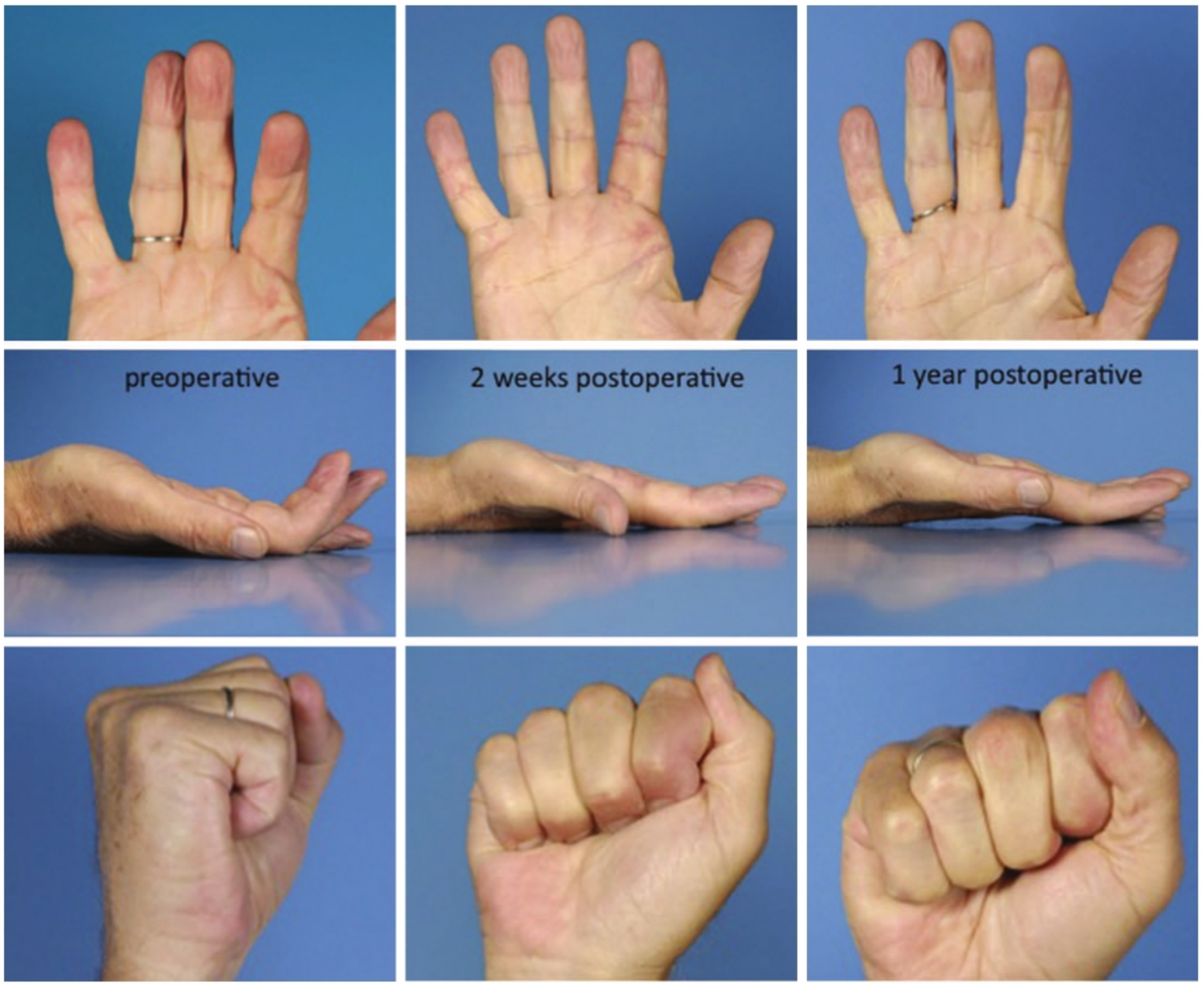

Fig. 3. Images of the same patient shown in Figure 1, with Dupuytren contracture in the second ray. The palmar view (*above*), lateral view (*center*), and fist position (*below*) are shown preoperatively (*left*), 2 weeks postoperatively (*center*), and 1 year postoperatively (*right*).

inherently long recovery time of fasciectomy, however, have fueled the emergence of less invasive techniques[1,12] such as the injection of collagenase. A recent randomized clinical trial compared collagenase injections with a placebo. Patients received up to three direct injections 30 days apart, requiring an average of 56 days. At 30 days' follow-up, metacarpophalangeal and proximal interphalangeal joint contractures improved significantly. Two tendon ruptures and one case of complex regional pain syndrome were reported.[13] Although the procedure seems to have merit, the treatment is costly, and long-term follow-up data are lacking. Collagenase has not been compared directly to a nonplacebo alternative and is presently limited to one affected joint at a time.

Needle aponeurotomy is another minimally invasive technique.[8,14,15] In a randomized clinical trial comparing needle aponeurotomy versus limited fasciectomy,[7] a 75 percent reduction in metacarpophalangeal joint extension deficit and a 33 percent reduction in extension deficit for the proximal interphalangeal joint at 6 weeks' follow-up was reported in the needle aponeurotomy group. The minor complication rate was 50 percent in the needle aponeurotomy patients versus 30 percent after open surgery; major complication rates were 0 percent and 5 percent. This is in line with reported complications of skin rupture, infection, digital nerve transection, tendon ruptures,[16] and even the development of a false aneurysm.[17] At the 2010 European Association of Plastic Surgeons meeting in Manchester, van Rijssen et al. reported an 85 percent recurrence rate at 5-year follow-up in the needle aponeurotomy group (unpublished data).

The needle technique in our new procedure was refined compared with conventional needle aponeurotomy by using multiple superficial nicks in the pathologic region. The essence of the needle technique is not to use the needle too deep, especially more distally. To ensure this, the bevel of the needle is never completely out of sight. There is no attempt to transect the cord with one needle cut; this would take the needle too deep, which could damage tissues other than the diseased fascia. There is no limit to the amount of rays that are treated; even nodules in other rays can be treated in the same session.

Fat grafting is a critical component of this new procedure. One reason for this is to provide supple skin by supplying fat. Dupuytren contracture is associated with subdermal fat deficiency as the pathologic fibrosis displaces the fat to adhere to the dermis. This new procedure releases the fibrous scar from the dermis and restores a subcutaneous fat layer over the affected area. A second reason is that interposed grafts are reported to prevent the recurrence of Dupuytren contracture.[18] In our procedure, interposed fat grafts in the space created by the released fibers might have a similar beneficial effect. Furthermore, because these fat grafts come from the abdomen, a region of the body not prone to contracture, it is likely that they will not have the same tendency to convert into fibrous bands. A third reason is that fat grafting is known to be a rich source of stem cells with regenerative potential.[19] Fat grafting has been shown to improve the quality of the skin and to be beneficial in the treatment of radiation damage,[20] chronic ulceration, and scar tissue around breast capsular contractures.[19] Because the pathophysiology of Dupuytren contracture is akin to that of a scar, it would seem logical that fat grafts would also be beneficial in this disease setting.

Extensive percutaneous aponeurotomy differs notably from needle aponeurotomy, an office procedure performed under local dermal anesthesia. Needle aponeurotomy specifically avoids lidocaine infiltration of the neurovascular bundles such that an attentive patient with sensate nerves is the safeguard against nerve injury during deep full-thickness needle transections of the cord. In contrast, extensive percutaneous aponeurotomy is performed on a prepared and draped hand in the operating room under regional block with tourniquet ischemia and sedation. Safety from nerve injury is inherent in the extensive percutaneous aponeurotomy design as a result of the difference in stiffness of the stretched cords and the nerves (see earlier under Patients and Methods).

Drawbacks of our new technique could be accidental damage of surrounding nerves, digital arteries, and tendons. In our combined series treated in Rotterdam and Miami, no tendon lesions were encountered and there was only one infection. One nerve was injured in a recurrent diseased finger, and in four cases a complex regional pain syndrome evolved. Two of these patients already had a complex regional pain syndrome in the contralateral hand following earlier open surgery. Another drawback of extensive percutaneous aponeurotomy is that the arthrogenic part of the flexion contracture cannot be corrected. With extensive percutaneous aponeurotomy, only the dermatofibrous contractures can be released, which may leave a residual capsulogenic contracture. Many experienced surgeons, however, are often also not inclined to release a capsulogenic contracture during open surgery because of the potential stiffness of the proximal interphalangeal joint or reactive recurrence of the proximal interphalangeal contracture.

Our clinical study of course has limitations. We have treated 91 patients and can report on goniometry data from only 50 patients. As we do not have long-term follow-up results, recurrence rates do not seem appropriate yet. In addition, our patients may not reflect the normal Dupuytren population because the Erasmus University Medical Center is a referral center, with 39 percent of its patients having a severe diathesis. Another limitation was that an independent researcher measured the range of motion and therefore there was no blinding.

Comparing the extensive percutaneous aponeurotomy results with the needle aponeurotomy results in the literature is difficult, as we selected the worst finger per patient instead of adding all rays regardless of the number of patients. Furthermore, the number of patients differs, follow-up time differs, and the percentage of patients with severe diathesis is high in our series. It seems, however, that our data concerning the metacarpophalangeal joint are favorable, as improvement is 100 percent compared with 79 percent[16] and 75 percent in needle aponeurotomy–treated patients.[7] For the proximal interphalangeal joint, our contractures were significantly more severe (preoperative mean, 61.3 degrees compared with 37 degrees).[16] Improvement of the proximal interphalangeal joint was 56 percent in our study compared with 65 percent in the article by Foucher et al.[15] and 33 percent in the article by van Rijssen et al.[7]

Based on these preliminary results, extensive percutaneous needle aponeurotomy with subdermal fat grafting has great potential. Patients with Dupuytren disease mostly need multiple opera-

tions during their life, so a less invasive surgical method should be a treatment of first choice. To achieve a higher level of scientific evidence, we started a single-blind, multicenter, randomized controlled trial in Rotterdam to compare the new minimally invasive surgery with the surgical limited fasciectomy or dermatofasciectomy.

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