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Modified percutaneous needle aponeurotomy for the treatment of dupuytren's contracture: early results and complications

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Abstract
Background The purpose of our study was to identify postoperative results and complications using a percutaneous approach to treat Dupuytren's contracture in a consecutive series of patients.
Methods A review of all patients with Dupuytren's contracture treated with percutaneous needle aponeurotomy (NA) from 2008 to 2010 was performed. Patient demographics, digits affected, and disease severity was recorded. Preoperative total passive extension deficit (TPED) was calculated for each affected digit. TPED in the immediate postoperative period and at the time of most recent follow-up was measured. Treatment-related complications and incidence of disease recurrence were identified. Statistical analysis was performed using paired t-test. (Statistical significance p-value <0.05).
Results 525 digits in 193 hands were treated with NA. 140 patients were male, average age was 65 years. The average preoperative TPED was 41° and the average immediate postoperative TPED was 1° (98% correction) (P=0.0001). The average TPED at 4.5 month follow up was 11 o (73% correction). Complications included infection in 3 patients and one case each of triggering, delayed flexor tendon rupture, complex regional pain syndrome and persistent numbness. Recurrence was observed in 62 digits.
Conclusion Percutaneous needle aponeurotomy is an effective technique in the treatment of Dupuytren's contracture. Near complete correction of contracture was achieved and few complications were observed. Longer follow-up is needed to determine if these short-term results are maintained.

Keywords Dupuytrens contracture · Needle aponeurotomy · Complications

Introduction

Dupuytren's disease is a fibroproliferative disorder of palmar and digital fascia that may result in contractures at the metacarpophalangeal and interphalangeal joints [12]. Although first described by Henry Cline in the 1800s [3, 8], Baron Guilluame Dupuytren is credited based on his published report in 1831 [4, 7]. Since these early descriptions, many surgical approaches for the treatment of symptomatic contractures have been described [5, 9, 11, 13, 14, 18]. Treatment options include radical fasciectomy, dermofascietcomy, limited fasciectomy, percutaneous fasciotomy, and, recently, collagenase injection [5, 9, 10, 11, 13, 14, 18]. Recent years have seen a shift in interest towards less invasive treatment alternatives. The percutaneous approach has the benefit of rapid recovery, quick return to work, minimal healing time, and infrequent need for formal occupational therapy [6]. Previous descriptions of the PNA technique report better ability to correct contractures at the metacarpophaleangeal (MP) joint relative to the proximal interphalangeal (PIP) joint. [1, 2, 9, 16–18] Over the last 5 years, the percutaneous technique has become our primary mode of surgical treatment of Dupuytren's contractures. We have incorporated a number of technical modifications that

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allow extensive cord division in the palm and digits to improve contracture correction, particularly at the PIP joint. The purpose of our study was to report our initial postoperative results following needle aponeurotomy as well as to identify short-term complications with our modified technique.

Materials and Methods

Institutional review board approval was obtained for this study. We identified from a surgical database all patients treated with percutaneous needle aponeurotomy (NA) as the primary mode of treatment for Dupuytren's contracture between the years of 2008 to 2010. This was a consecutive series of patients operated on by a single surgeon. We included all digits with contractures greater than 20° at the metacarpophalangeal joint or greater than 15° at the proximal interphalangeal joint in this review. Patients who had undergone prior surgical release in the affected digits were excluded from analysis. Data on patient demographics, severity of disease, number of digits involved, preoperative contracture measurements, immediate postoperative results, complications, and follow-up contracture measurements were identified from medical records, operative reports, and outpatient charts. Contracture measurements were obtained for each involved joint using a standard digital goniometer. The total passive extension deficit (TPED) was then calculated by adding the measurements from each joint of the involved digit. This calculation is the sum of the degrees of flexion remaining at all joints of each finger. This results in a single measurement for each involved digit. Digits were stratified by contracture severity using the Tubiana classification system (Tubiana I, 0–45°; Tubiana II, 45–90°; Tubiana III, 90–135°; Tubiana IV, >135°) (Fig. 1) [15]. This classification system is also based on TPED. Major complications were defined as infection, hematoma, skin slough, suspected injury to digital vessels or nerves requiring exploration, and suspected tendon injury. Intraoperative skin tears were noted but were not considered to represent a major complication.

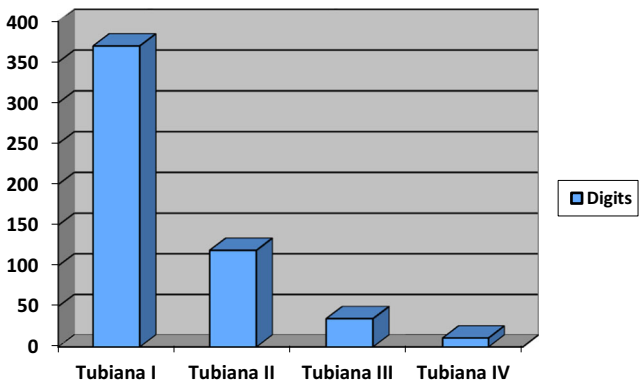

Fig. 1 Severity score of involved digits using Tubiana scoring system

A total of 525 digits in 193 hands were treated with NA for primary disease from 2008 to 2010. One hundred and forty patients were male and 42 were female for a total of 182 patients treated. Eleven patients had bilateral hands treated. The mean age was 65 years, ranging from 37 to 88 years. There were 362 digits classified as Tubiana stage I, 118 Tubiana II, 34 Tubiana III, and 11 Tubiana IV.

Statistical analysis was performed using paired sample *t* test for comparison of preoperative, immediate postoperative, and follow-up measurements. Statistical analysis was performed using GraphPad Prism 5 for Windows software. (a p value of <0.05 was considered statistically significant).

Surgical Technique

All procedures are performed under local anesthesia without sedation. The patient rests supine with the arm abducted on a hand table. No tourniquet is used during the case. Surface anesthesia is achieved by superficial injection of the skin directly overlying the Dupuytren's cords with 1 % lidocaine with 1:100,000 epinephrine solution using a 1-mL syringe and a 29-gauge needle. The injections are carefully placed at an intra-dermal or very superficial subdermal level in order to anesthetize the skin only and to avoid anesthetizing the digital nerves. Only a small amount of anesthetic is injected at each entry site (roughly 0.05 mL). Subcutaneous infiltration is avoided. The appropriate level of anesthesia is critical to avoid later injury to the underlying digital nerves and vessels. The presence of intact distal sensation in the pulp of each digit is assessed prior to aponeurotomy to ensure that digital nerve function remains intact.

Our technique aims for a more extensive cord division relative to prior descriptions of percutaneous aponeurotomy. An 18-gauge needle is used as a percutaneous fasciotome in a controlled sweeping fashion to divide the diseased cords. Release is begun from proximal to distal along pretendinous cords in the palm. The cords are tensioned by gentle passive extension of the affected digit during release. Numerous needle portal sites are used (typically >10 per digit), and release is continued until no further regions of cord tension are palpable and all fibrotic skin is released. Remaining midline on the pretendinous cords avoids injury to the adjacent neurovascular structures. Care is taken in the distal palm at the level of the flexor sheath to avoid over-penetration with the needle as the flexor tendons are in a relatively superficial position. Tensioned cords should provide a crisp feel against the needle tip and audible feedback during release. If no resistance is met or there is a soft or rubbery feel, the portal is abandoned. It is also important to avoid hyperextension of the MP joints during this portion of release as this maneuver will bring the flexor tendons even more superficial and increase risk of injury. Natatory cords in the 2nd, 3rd, and 4th webspaces are

released in a vertical motion. The fingers should be actively flexed and extended following needle insertion to confirm that the needle has not entered into the flexor tendon.

Spiral and lateral cords extending into the digits require increased caution but are also addressed. Upon insertion of the needle at these levels prior to cord division, the patient is asked to report any paresthesias or electrical sensations that would indicate proximity of the needle to the digital nerve. If no symptoms are reported, the cord is carefully divided in a gentle sweeping fashion. Cords are followed across the PIP joint into the middle phalanx and divided as necessary to release tension. We have found that in regions of nodule formation, the distal-most aspect of the nodule provides a reliable target for release.

At the completion of the fasciotomy portion of the procedure, the palm is infiltrated with 0.25 % bupivacaine solution. The digits are then passively extended to complete rupture of the cords. If cord rupture does not achieve complete correction of PIP contractures, a closed capsulotomy of the PIP joint is performed. These maneuvers may result in small skin tears in patients with more severe contractures. Patients are shown these skin tears and instructed on how to care for them. These are then dressed with bacitracin ointment and xeroform gauze, and a bulky dressing is applied to the hand. The patient is referred to a hand therapist within the next few days where the dressings are changed and a thermoplastic night extension splint is made and worn for 6 weeks. Although supervised therapy is not usually required in patients with mild contractures, for patients with a more severe disease (Tubiana stages III and IV), a 6-week course of therapy is typically prescribed.

Results

Preoperatively, the mean MP contracture was 30° and the mean PIP contracture was 33°. The mean preoperative TPED was 41°. The mean initial postoperative TPED was 1°. Compared to the preoperative TPED, this difference was statistically significant (p=0.0001). Table 1 summarized the initial postoperative correction based on affected joints. The mean initial postoperative MP contracture was <1°, and the mean PIP was 2°. Digits were further stratified based on the severity of contractures. Mild to moderate contractures (Tubiana I/II) had a mean percent correction of 100 % at the MP joint and 95 % at the PIP joint (Table 2). Severe contractures (Tubiana III/IV) had a mean percent correction of 99 % at the MP and 92 % at the PIP joint. The mean follow-up was 4.5 months, ranging from 1 week to 28 months. The mean TPED at follow-up was 11° for all patients with a mean percent correction of 73 % (81 % at the MP joint and 58 % at the PIP joint).

Minor skin tears were noted in 68 % of our patients. There were seven major complications. This included triggering in one patient, infection in three patients, complex regional pain syndrome in one patient, delayed flexor tendon rupture in one patient, and persistent numbness that required nerve exploration in one patient. Two of the infections presented as flexor tenosynovitis of the involved digit. These both required formal incision and debridement on postoperative days 6 and 19, respectively. The third patient presented 1 month after NA with superficial abscesses of the palm and digits that were treated with local incision and debridement. The patient with postoperative triggering was treated with a corticosteroid injection after which his symptoms resolved. The patient who developed complex regional pain syndrome was treated with stellate ganglion blocks with resolution of symptoms. The patient with delayed presentation of rupture of the flexor digitorum profundus of the right middle finger underwent exploration of the digit with flexor superficialis to profundus transfer and reconstruction of the A-2 pulley. One patient with persistent numbness of the index, middle, and ring finger underwent exploration on postoperative day 18 which identified intact neurovascular structures without overt evidence of injury. Recurrence, defined as the development of contracture > 20 degrees beyond the immediate postoperative TPED, was observed in 62 digits (12 %).

Table 1 Distribution of contractures among affected digits

Digits involved	MP	PIP	DIP
525	456	250	14
Mean % corrected	100	94	100

Discussion

Our results compare favorably with the existing literature. According to our study, we were able to obtain excellent initial results (99 % corrected) with a low complication rate. The mean percent corrected at the MP and PIP joint was 99 and 92 %, respectively. Previous studies have shown improvement at the MP joints ranging from 70 to 90 %, while the PIP joint improvement ranged from 46 to 65 %. [1, 2, 9, 16, 18]. Although greater care is required during release of cords extending into the digit to avoid neurovascular injury, our

Table 2 Overall contracture deformities preoperative, postoperative, and at follow-up based on severity

Severity	Preoperative TPED	Postoperative TPED	Follow-up TPED
Mild (Tubiana I/II)	33	0.5	5.3
Severe (Tubiana III/IV)	121	4.4	18

current surgical technique allows contractures at the interphalangeal joints to be reliably treated.

Prior studies on the percutaneous treatment of Dupuytren's contracture have shown significant improvements in TPED [1, 2, 5, 9, 18]. Duthie et al. described their long-term results of 82 patients treated with percutaneous fasciotomy. The mean preoperative deformity was 71°. This was corrected to a mean of 22° at the completion of the procedure for a 70 % postoperative improvement. At a 10-year follow-up, they noted only a mean 20 % postoperative improvement [5]. Foucher et al. described their experience with percutaneous needle fasciotomy in 311 digits for primary disease. Postoperative improvement was 79 % at the MP joint opposed to 65 % at the interphalangeal joint. Their recurrence rate was 52 %, and one digital nerve was injured in their series [9]. van Rijssen et al. published a prospective study of 52 patients treated with NA in 2006. One week after surgery, they observed a mean reduction of TPED of 77 % (88 % at the MP joint and 46 % at the PIP joint). At a mean follow-up of 32 months, they reported a 65 % recurrence rate [18]. The same group further published a prospective, randomized control study directly comparing NA to limited open fasciectomy in 113 patients. At 6 weeks, they reported TPED to be improved by 63 % in the NA group compared to 79 % in the fasciectomy group [16]. No major complications in the NA group were observed. There were three major complications (digital nerve injury, infection, and hematoma) in the fasciectomy group. Pain scores and patient satisfaction with hand function were better among the NA group at 6 weeks.

In our study, we report a skin tear rate of 68 %. This is somewhat higher than prior literature suggesting skin tears in one third of patients after percutaneous needle aponeurotomy [6]. While it is important to warn patients preoperatively of the possibility of skin tearing, we do not consider skin tear complications but rather anticipated occurrences due to the loss of skin elasticity and relative skin deficiency in chronically contracted digits. It is expected that many patients will have skin tears if contractures are aggressively released. This may be partially technique dependent given the larger caliber needle (18 g) used in our study. We also find that the skin can be fibrotic limiting straightening of the digits, and if the skin is treated aggressively, we are able to get the digits initially straight; however, these results in high skin tear rates. The vast majority of these tears can be expected to heal within 2–3 weeks. All skin tears in this series were treated with local wound care only and did not preclude active mobilization postoperatively.

In our series, recurrence was observed in 12 % of digits, which is lower than previous studies. Current literature cites mid- to long-term recurrence rates following NA to range from 45 to 85 % [2, 5, 9, 16, 18]. The differences in follow-up, definition of recurrence, and measuring techniques likely account for the wide variation in the literature. We defined recurrence as the presence of contracture $\geq$20° beyond the immediate postoperative TPED in a previously treated digit. Although the low recurrence rate in our study is likely primarily due to the short-term follow-up, our surgical technique does differ from that used in prior reports by using a larger bore needle and aggressive release of fibrotic skin. We speculate that the more extensive cord disruption achieved by our technique may lower the rate of recurrent contracture, though longer follow-up is necessary to support this hypothesis.

Needle aponeurotomy has been criticized due to high rates of recurrence relative to open fasciectomy procedures. However, the implications of recurrence following NA may be different than that following open release. We have found that the majority of patients with recurrent disease after NA may be treated safely and effectively with a repeat NA procedure. Our preliminary experience has been that satisfactory contracture correction can be achieved with less surgical difficulty, fast recovery, and high rates of satisfaction relative to revision open procedures. van Rijssen reported a similar trend in which 26 of 45 patients with recurrent disease following percutaneous needle fasciotomy chose to undergo a second treatment with percutaneous needle fasciotomy. None of the nine patients with recurrence following open fasciectomy chose repeat fasciectomy. Four of these nine patients chose to have recurrent contracture treated with percutaneous needle fasciotomy [17].

We acknowledge that several limitations exist within our study. These include the retrospective nature of the study design and lack of patient-reported functional outcome measures. There was also some variability in postoperative rehabilitation. Most patients were treated with self-directed motion exercises. However, patients with more severe contractures were referred at the treating surgeon's discretion for formal hand therapy, and we did not directly assess this variable. We also recognize that our patient follow-up is limited. Given that the recovery time is short, many patients do not return for routine office visits beyond the initial postoperative period. Longer follow-up is needed to determine the durability of the percutaneous technique.

Conclusions

Percutaneous needle aponeurotomy is an effective technique in the treatment of primary Dupuytren's disease. A near-complete correction of contractures of the metacarpophalangeal joints and the proximal interphalangeal joints with minimal complications can be obtained.

The key to avoiding complications is sound surgical technique and superficial placement of local anesthetic to allow patient involvement during the operation.

Conflict of Interests Fernando Herrera declares that he has no conflict of interest.

Scott Mitchell declares that he has no conflict of interest.

Mark Elzik declares that he has no conflict of interest.

Prosper Benhaim declares that he has no conflict of interest.

Statement of Human and Animal Rights The procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000 and 2008.

Statement of Informed Consent Additional informed consent was obtained from all patients for which identifying information is included in this article.

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