Original Article

Versatility of percutaneous needle fasciotomy for Dupuytren's disease across a spectrum of disease severity: A single-surgeon experience of 118 rays ☆

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ABSTRACT

Background: Percutaneous needle fasciotomy (PNF) represents the only minimally invasive approach for treatment of Dupuytren's disease in Europe since withdrawal of collagenase from European markets. Though well-established, surgeon preference and uncertainty regarding safety and efficacy, results in limited provision in favour of open fasciectomy.

Methods: A retrospective review of 74 patients who self-opted to receive PNF between 2017 and 2020 was conducted. Demographic data, complications and degree of release achieved were compared across three cohorts based on contracture severity as per Tubiana staging (TS): Stage 1, 0–45°; Stage 2, 46–90°; Stage 3, 91–130° with χ^2 analysis.

Results: One hundred and eighteen rays were treated amongst 74 patients (mean age, 68 years (R, 32–86), males: 74%) with mean follow-up 51 weeks (IQR 28–76 weeks) with no significant difference in baseline characteristics across cohorts. No cases of permanent sensory disturbance, flexor tendon rupture, arterial transec-

tion nor infection were observed. Neuropraxia was seen in six pa-
tients, resolving with mean recovery of 6 weeks. 86% ($n = 166$)
of joints had satisfactory release (residual passive extension deficit
(PED) $\leq 10°$) with full release in 67%. Full release was most likely
in metacarpophalangeal joint (MCPJ; 93%) than distal interpha-
langeal joint (DIPJ; 67%) or proximal interphalangeal joint (PIPJ;
45%; $p<0.0001$). Mean release was 54° in MCPJ and 56° in PIPJ.
All TS1 patients achieved release with $\leq 10°$ residual PED versus
75% of TS2 patients and 22% of TS3 patients ($p<0.05$), the latter
of whom had a mean residual PED of 12° Ninety-two percent of
patients stated they would undergo PNF again if necessary, in pref-
erence to open fasciectomy.

Conclusion: We find PNF to facilitate a safe, effective yet mini-
mally invasive approach amongst patients of varying disease sever-
ity, across different age groups, with recurrent disease, associated
comorbidities or concurrent anticoagulation therapy. Patients re-
ported high satisfaction in preference to open procedures. We,
therefore, intend to recommend PNF first-line to all patients re-
gardless of disease severity.

Introduction

Dupuytren's disease, eponymously described by Baron Guillaume Dupuytren in 1831, is a progres-
sive fibroproliferative pathology of the palmar fascia leading to fixed flexion deformity and significant
difficulties with activities of daily living.[1] In the UK, Dupuytren's disease affects 20.9 per 10,000 peo-
ple with evidence to suggest increasing incidence.[2]

Since inception by Lermusiaux and Debeyre in 1979, percutaneous needle fasciotomy (PNF) has
become a well-established approach to releasing contracture of affected rays. Since the withdrawal of
microbial collagenase injection from European markets in November 2019 PNF is the only minimally
invasive treatment option currently available in Europe.[3] Amongst its advantages, it requires minimal
staffing and resources and additionally facilitates full function of the treated hand with immediate
mobilisation in the post-operative period. However, factors relating to surgeon preference and per-
haps concerns regarding the potential risk of permanent digital nerve damage, flexor tendon rupture,
arterial transection or infection have resulted in limited provision of PNF with many surgeons consid-
ering open fasciectomy with regional or general anaesthetic to be the gold standard.[4,5]

The purpose of this study was to determine the safety and efficacy of PNF when delivered as the
treatment of choice for Dupuytren's disease. In particular, the authors wanted to ascertain the degree
of release which could be achieved in each joint, across a spectrum of Tubiana[6] disease severity and
determine whether clinically significant release could be achieved in patients with severe contrac-
tures.

Patients and methods

Patients

Between October 2017 and June 2020, all patients referred to a tertiary care unit under the senior
author for Dupuytren's release were offered PNF amongst other treatment modalities including open

or segmental fasciectomy and collagenase therapy which was offered only when available within the European Union. According to principles of informed consent, all patients were given standardised counselling and advice regarding the benefits and risks of each therapy. As such, selection bias was minimised and only patients who self-opted to receive PNF ahead of other treatment modalities were included. This cohort was identified via hand physiotherapy records.

Data collection

In this retrospective review, in which STROBE[7] guidelines were adhered to, data were compiled from patient medical records, including age, gender and peri–operative risk factors, such as smoking status, presence of diabetes mellitus, other cardiovascular comorbidity as well as anticoagulation status.

Patients were divided into three cohorts based on their most severe joint contracture angle according to Tubiana staging: Stage 1, 0°–≤45°; Stage 2, 46°–≤90°; Stage 3, 90°–≤130°[6] Factors revealing high Dupuytren's diathesis were noted, including age < 50 years at presentation, recurrent or bilateral disease, extra-palmar manifestation or liver disease.[8] Length of follow-up was determined as the period between the procedure and last contact.

Primary outcomes were degree of passive extension achieved post-operatively and incidence of major surgical complications including permanent sensory disturbance, flexor tendon rupture or infection. Minor short-term complications were defined as small (<1 cm) skin tears which required suturing or any self-limiting disturbance in sensation including neuropraxia.

A secondary outcome was patient satisfaction, with regard to patients who were followed-up during the coronavirus disease 2019 (COVID-19) period. This was assessed by asking whether the patient would undergo the procedure again if necessary, in preference to an open approach with general or regional anaesthesia. These patients were consulted via telemedicine as in-person follow-up was not possible. Disease recurrence was defined as an increase of at least 30° contracture in a single joint during follow-up, in comparison with the immediate post-operative measurement.[9]

Statistical methods

The χ^2 statistical test was used for categorical data as appropriate while one-way ANOVA was used for numerical data when evaluating three cohorts. Independent *t*-test analysis was employed to compare two-level data. A p-value of < 0.05 was deemed statistically significant.

Operative technique

The technique described is a minimally invasive procedure and as such may be carried out in treatment rooms by a surgeon and a single assistant: Following sterile draping, patients are prepped with aqueous betadine. Upon passive extension of affected rays, all palpable cords are identified and marked. A tourniquet is not applied. Considerations for selecting sites of fasciotomy include the most prominent parts of each cord, yet where the skin is not so densely adherent as to risk skin tear. The most evasive cords, for example with natatory or retrovascular morphology, are chronologically prioritised.

A 10-ml syringe is loaded with 2 ml of 2% plain lignocaine and a 21-gauge 16 mm needle is mounted. With the bevel aligned to syringe markings, the patient is informed before the needle is inserted into the subcutaneous skin overlying the cord. The quantity of lignocaine injected in each fasciotomy site is minimal to induce anaesthesia only in the overlying skin, keeping digital nerves sensate. Crucially, this ensures patients are aware if the needle approaches the digital nerve and minimises risk of nerve trauma.

The contracture is released sequentially by repeatedly puncturing the cord in a 360° fashion avoiding complete withdrawal of the needle before moving to a different fasciotomy site. The needle is 'swivelled' laterally to further interrupt the cord. Two to three fasciotomies are typically required to release each palpable cord with needle replacement as often as to retain a sharp cutting edge. Affected rays are then anaesthetised with a ray block using 0.25% bupivacaine. Passive manipulation to

Table 1
Baseline patient characteristics.

	All patients (n = 74)	Tubiana Stage 1 (n = 14, 19%)	Tubiana Stage 2 (n = 51, 69%)	Tubiana Stage 3 (n = 9, 12%)	P
Median age, years (range)	68 (32–86)	69 (32–81)	69 (36–86)	74 (52–82)	0.351[†]
Dupuytren's diathesis, n (%)					
Age < 50 years	3 (4)	1 (7)	2 (4)	0 (0)	0.694
Recurrent disease	17 (23)	2 (14)	13 (25)	2 (22)	0.677
Previous intervention	25 (34)	2 (14)	20 (39)	3 (33)	0.217
Bilateral disease	16 (22)	3 (21)	11 (22)	2 (22)	0.999
Extra-palmar involvement	4 (5)	1 (7)	3 (6)	0 (0)	0.734
Liver disease	4 (5)	2 (14)	1 (2)	1 (11)	0.141
Gender, n (%)					
Male	54 (73)	10 (71)	36 (71)	8 (89)	0.517
Smoking status					
Current smoker	4 (4)	0 (0)	4 (8)	0 (0)	0.385
Ex-smoker	24 (32)	7 (50)	14 (27)	3 (33)	0.279
Non-smoker	27 (36)	4 (29)	19 (37)	4 (44)	0.727
Not recorded	19 (26)	3 (21)	14 (27)	2 (22)	–
Comorbidity, n (%)					
Cardiovascular disease*	42 (57)	8 (57)	29 (57)	5 (56)	0.997
Diabetes	7 (9)	1 (7)	4 (8)	2 (22)	0.376
Anticoagulation or antiplatelet therapy	15 (20)	2 (14)	12 (24)	1 (11)	0.573
Procedure laterality (n = 84)					
Right	45	10	30	5	–
Left	39	8	27	4	–
Follow-up, weeks, (range)	51 (4–137)	58 (5–114)	51 (5–137)	40 (4–86)	0.389†

* Includes presence of hypertension, atrial fibrillation, valvular disease, ischaemic heart disease, stroke, abdominal aortic aneurysm and peripheral arterial disease. X^2 was used for categorical data.
† One-way ANOVA.

further release the cords while stretching the collateral ligaments and volar plate is subsequently performed to achieve maximal release as shown in Figure 1. A small self-adhesive dressing is applied, and the patient is immediately seen by hand-therapy for fitting of a thermoplastic splint.

Post-operative management

Patients are advised to wear the splint for 3 weeks, with temporary removal for short intervals as needed. After this period, nightly splintage for 3 months is recommended.

Results

Eighty-eight patients were identified from hand physiotherapy records who were verified by review of medical files. Fourteen patients were thus excluded; three patients had received open segmental fasciectomy, one patient was deceased, four patients were lost to follow-up and a further six patients were treated by a different surgeon.

In total, 74 patients were included in the study cohort who collectively underwent 84 chronologically distinct procedures in 118 rays. There was no significant difference in demographics between treatment cohorts (Table 1). Mean follow-up was 51 weeks (IQR 28–76 weeks, range 4–137 weeks). Characteristics of treated rays, including cord morphology and median joint passive extension deficit (PED), are shown in Table 2.

No major surgical complications were observed in any patient, including no instances of permanent sensory disturbance, flexor tendon rupture, haematoma nor infection. Cases of transient sensory disturbance which were classified as neuropraxia occurred in six patients (7%), all of which resolved with a mean recovery time of 6 weeks. Minor surgical complications, such as skin tear of 1 cm or less occurred in ten patients (12%) of whom nine required suturing and healed without complication

Figure 1. Pre- and post-operative images of two cases. A and B illustrate singular release of the PIPJ. C and D illustrate release of both PIPJ and DIPJ.

Table 2
Characteristics of rays treated for Dupuytren's disease.

Affected rays, (n = 118)*	
Ray involved, n (%)	
Little	59 (50)
Ring	40 (34)
Middle	15 (13)
Index	3 (3)
Thumb	1 (1)
Cord morphology*	
Pretendinous	77
Ulnar	40
Radial	10
Natatory	13
Retrovascular	3
Affected joints (n = 166)	
Median total PED (°)	
MCP (n = 74)	60
PIP (n = 83)	70
DIP (n = 9)	40

PED = passive extension deficit.
* Multiple cords were observed in single digits in many cases.

Table 3
Change in PED in each joint following PNF.

	All joints (n = 166)	MCP (n = 74)	PIP (n = 83)	DIP (n = 9)	P
Full release, n (%)	112 (67)	69 (93)	37 (45)	6 (67)	**<0.00001**
Mean baseline PED, ° (r)	54 (10–90)	54 (10–90)	57 (20–90)	45 (30–70)	0.536*
Residual PED ≤ 10°, n (%)	32 (19)	3 (4)	28 (34)	1 (11)	**0.000013**
Mean baseline PED, ° (r)	60 (10–110)	53 (20–70)	63 (10–110)	90	0.297†
Residual PED > 10°, ≤30°, n (%)	16 (10)	2 (3)	13 (16)	1 (11)	**0.022**
type="Other"Mean baseline PED, ° n (r)	78 (20–130)	70 (20–120)	88 (30–130)	15	0.245†
Residual PED > 30° n (%)	6 (4)	0 (0)	5 (6)	1 (11)	0.061
Mean baseline PED, ° (r)	93 (90–110)	–	94 (90–110)	90	–
Mean residual PED, ° (r)	58	–	62 (40–90)	40	–

Data are shown as number of joints. χ^2 statistical analysis used unless otherwise labelled. Bold font indicates statistical significance at p < 0.05.
* One-way ANOVA statistical analysis.
† Independent test analysis to compare MCP release versus PIP release.

within 1 week. Bruising occurred in nine patients (11%) while swelling was noted at nurse follow-up in two patients (2%). One instance of possible dermoid inclusion cyst was observed.

Full release was achieved in 67% (n = 166) of all joints with the greatest frequency of full release in the metacarpophalangeal joint (MCPJ) (93%), followed by the distal interphalangeal joint (DIPJ; 67%; p < 0.05), with the proximal interphalangeal joint (PIPJ) commonly affected by a ≤ 10° residual PED (Table 3). Eight-six percent of joints had clinically acceptable outcomes of release with ≤10° residual PED. On average, there was a 54° improvement in PED of the MCPJ and a 56° release of the PIPJ.

Predictably, full release was more likely to be achieved in patients with lower disease severity (p < 0.05; Table 4). All patients with Tubiana Stage 1 disease achieved satisfactory release (≤ 10° residual PED) compared with 75% of patients with Tubiana Stage 2 disease (Table 4). Seven of nine patients with Tubiana Stage 3 disease had a residual PED ≤30° illustrating considerable release is possible with this minimally invasive approach in severe disease. Recurrence during the study period was observed in 16% (n = 19) of all 118 treated digits or 18% (n = 15) amongst the 83 cases. No statistical difference

Table 4

Mean release achieved during each procedure and frequency of recurrence.

	All procedures (n = 83)*	Tubiana Stage 1 (n = 18)	Tubiana Stage 2 (n = 56)	Tubiana Stage 3 (n = 9)	P†
Full release, n (%)	35 (42)	14 (78)	21 (39)	0 (0)	**0.0002**
Mean residual PED ≤ 10°, n (%)	26 (31)	4 (22)	20 (36)	2 (22)	0.462
Mean residual PED > 10°, ≤ 30°, n (%)	15 (18)	0 (0)	10 (18)	5 (56)	**0.002**
Mean residual PED > 30°, n (%)	7 (8)	0 (0)	5 (9)	2 (22)	0.143
Mean residual PED > 30° (°)	59	–	61	55	–
Recurrence, n (%)	15 (18)	4 (22)	10 (18)	1 (11)	0.777

Data are shown as number of procedures undertaken. Bold font indicates statistical significance at p < 0.05.

* 1 procedure was excluded from this analysis as it was undertaken for digital abduction contracture.

† $\chi 2$ statistical analysis.

Table 5

Recurrence rates after a mean of 51 weeks.

Tubiana Stage	PNF	
	Recurrence, n (%)	Total digits, n (%)
Tubiana Stage 1	4 (22)	6 (19)
Tubiana Stage 2	10 (18)	12 (16)
Tubiana Stage 3	1 (11)	1 (1)
P†	0.777	0.744
All stages	15 (18)	19 (16)

† $\chi 2$ statistical analysis.

in recurrence was found between patient cohorts. Observed recurrences, shown by patient cohorts and by total number of treated digits, are shown in Table 5.

Regarding patient-reported satisfaction; 24 patients were followed-up during the COVID period of whom 22 stated that they would undergo PNF again, if necessary, in preference to an open procedure with general or regional anaesthesia. One patient said that they would prefer an open operation with full anaesthesia and one patient stated that they would not seek any further treatment.

Discussion

This study quantitatively compared degree of release achieved after PNF for Dupuytren's disease in patients of varying disease severity, who self-selected for PNF. Since the withdrawal of *C. histolyticum* collagenase therapy (Xiapex®, Swedish Orphan Biovitrum, Stockholm, Sweden) from the European market, PNF remains the only minimally invasive option for treatment of Dupuytren's disease.[3] In this series, all patients were treated using a single standardised technique by a single experienced hand surgeon, mitigating the risk of inter-operator variability. PNF was employed across a spectrum of disease burden resulting in satisfactory release (≤10° residual PED) in 87% of all treated joints, demonstrating the versatility of this approach. Two out of nine patients with Tubiana Stage 3 disease had residual PED > 30° suggesting limitations when releasing significant joint contracture, though a considerable degree of release is still feasible even in severe disease. Our data may be helpful in counselling patients pre-operatively and helping to inform the surgical team regarding the benefits and convenience of this minimally invasive technique.

On average, we identified a 54° improvement in PED in the MCPJ and additionally a 56° change during PIPJ release, figures which are comparable with that quoted in the PNF study by Pess et al., (2012),[10] yet somewhat higher than that quoted for open fasciectomy in a recent meta-analysis by Cooper et al. (2020).[11] The frequency of full release was significantly greater in the MCPJ (93%), than the PIPJ (45%), of which the latter frequently had residual PED of ≤30° (50%). This may be due to the anatomy of the PIPJ which may predispose to contracture of the collateral ligaments and volar plate as well as damage to the extensor aponeurosis over a period of fixed flexion deformity.[12]

Importantly, we identified no major adverse complications across the 118 rays including no instances of flexor tendon rupture, infection nor persistent sensory disturbance. The latter may be contingent to the operative technique whereby sensitivity of the digital nerve is maintained. An observational study of 3331 treated rays by Therkelsen et al. (2020) similarly found PNF to be a safe procedure with 0.03% incidence of nerve damage and 0.2% risk of flexor tendon rupture.[13] Likewise, an outcomes study of 1013 rays by Pess et al. (2012) [10] found no instances of tendon rupture, permanent nerve damage nor infection, while Molenkamp et al. (2017) [14] find a 0.2% risk of permanent sensory disturbance as well as flexor tendon rupture in their series of 451 patients. Interestingly, we have possibly identified the second reported case of dermoid inclusion cyst following PNF,[15] which, however, was of little significance to the patient.

All patients were counselled regarding potential risks of PNF including digital nerve damage and intra-operative discomfort given the absence of regional anaesthesia. Nevertheless, 22 of the 24 patients followed-up via telemedicine during the COVID period were satisfied with their treatment, stating they would opt to undergo PNF again if necessary, in preference to an open procedure with full anaesthetic. Although some patients may be slightly dissatisfied with the persistence of Dupuytren's nodules after PNF, this is perhaps outweighed by the opportunity to choose a scarless intervention whereby full function of the hand is conserved in the post-operative period facilitating immediate return to work.[16] Comparable results have been shown by Moog et al., (2019)[5] who report that 86% of patients treated in their series would opt for PNF again if necessary and similarly 82% of patients evaluated by Chambers et al. (2020).[17] Improvements in patient satisfaction have also been shown in validated patient-reported outcome measures (Poelstra et al., 2020),[18] while a recent systematic review of 20 randomised controlled trials showed consistently higher patient satisfaction in patients undergoing PNF versus open fasciectomy.[19]

PNF may be well-suited to a range of patient cohorts. For example, 46% of the patients in this series were elderly with age of at least 70 years, many with significant comorbidity for whom general anaesthesia or invasive surgery may not have been advisable. Furthermore, 21% of patients were anticoagulated or on antiplatelet therapy and were able to continue their prophylaxis as normal, with no additional complications. On the other hand, patients with high diathesis for Dupuytren's disease, including those who present at younger ages, may require multiple corrective procedures over their lifetime and may benefit from a non-surgical approach.[20] Repeat open fasciectomy may have several drawbacks including greater risk of damage to neurovascular bundles, devascularisation of overlying skin and increased scarring resulting in poorer outcomes.

It is difficult to directly compare rates of recurrence due to inconsistencies in recurrence definition. Indeed, we observed recurrence, as defined by van Rijssen AL and Werker, (2006),[9] in 16% of treated rays during the follow-up period, with no statistical difference in recurrence with increased severity of disease. We find similarities between our findings and quoted recurrence rates for both PNF and open fasciectomy in studies with longer follow-up: Roulet et al. (2018)[21] found a 17.5% recurrence rate 21.5 years following PNF, while Ferreira et al. (2020)[22] observed recurrences in 12% during their ten-year experience. Likewise, Selles et al. (2018)[23] identified recurrence in 21% five years following limited fasciectomy in their randomised controlled trial, perhaps strengthening the argument that a minimally invasive needle approach may be a preferential alternative for patients presenting with Dupuytren's disease.[24,25]

Limitations to our study are four-fold: firstly, we undertook a retrospective review which may have been affected by incomplete records. Secondly, though the risk of selection bias was minimised by including patients who self-opted to receive PNF when offered together with open fasciectomy, this may have led to some inherent uptake bias. Thirdly, though assessment of recurrence was not a primary objective of our study, it was partially determined via telemedicine follow-up and sometimes dependant on the patient's own assessment. Finally, there may have been inaccuracies in verifying this rate due to disparities in follow-up time.

In our series, release of each ray was expected to take no longer than 20 min by a single performing surgeon and a surgical assistant. This is in contrast to an open approach, which takes significantly longer,[26] requires an anaesthetist to perform either a general anaesthetic or a regional block as well as substantially greater resources and arguably more intensive post-operative wound care. Two previous cost-based analyses have found that open fasciectomy may not be as cost effective in comparison to

minimally invasive approaches,[27,28] while Davis et al. (2020)[26] find that there is on average a seven-fold increase in cost from £111 in PNF to £777 in open fasciectomy.

In conclusion, this study highlights the suitability of PNF as a convenient, minimally invasive option for treatment of Dupuytren's disease, especially desirable in helping to minimise morbidity in a climate of limited surgical provision relating to the ongoing coronavirus pandemic. Interestingly, all three cohorts of patients including those with Tubiana Stage 3 disease had clinically significant release with the advantages of undergoing scarless surgery, without the need to stop anticoagulation while retaining full function of the hand in the immediate post-operative period. We found that PNF consistently yields safe, effective and reliable outcomes amongst patients across different age groups, with recurrent disease, associated comorbidities, concurrent anticoagulation therapy and importantly varying severity of disease. The results of our study have led to changes in our practice, as we intend to recommend PNF first-line to all patients regardless of disease severity.

Declaration of Competing Interest

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Ethical approval

As the work presented subsequently was deemed a 'service evaluation' using anonymised data from which results could not be generalised beyond our unit, ethical approval from the Research Ethics Committee was not required as per the NHS Health Research Authority Guidelines.

Informed Consent

Informed consent was sought from all included patients. The photographs used in this manuscript are reproduced with full written consent of the patients involved.

Authorship Details

Both authors made a substantial contribution to (i) the concept, design of the work, data analysis and interpretation; (ii) drafting the article and revising it critically for important intellectual content; (iii) gave approval for the final version to be published and (iv) have participated sufficiently in the work to take public responsibility for the content.

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