

# Surgical management of Dupuytren's contracture in Europe: regional analysis of a surgeon survey and patient chart review

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## SUMMARY

**Aim:** We explored regional variations in the surgical management of patients with Dupuytren's contracture (DC) in 12 European countries using a surgeon survey and patient chart review. **Methods:** Twelve countries participated: Denmark, Finland, Sweden (Nordic region); Czech Republic, Hungary, Poland (East); France, Germany, the Netherlands, UK (West); Italy, Spain (Mediterranean). For the survey, a random sample of orthopaedic/plastic surgeons (n = 687) with 3–30 years' experience was asked about DC procedures performed during the previous 12 months. For the chart review (n = 3357), information from up to five consecutive patients was extracted. Descriptive statistics are reported. **Results:** Ninety-five per cent of all surgeons used fasciectomy for DC, followed by fasciotomy (70%), dermofasciectomy (38%) and percutaneous needle fasciotomy (35%). Most surgeons were satisfied with fasciectomy over other procedures. Recommended time away from work and duration of physical therapy increased with the invasiveness of the procedure. The intra-operative complication rate was 4.0%; the postoperative complication rate was 34%. Overall, ≥ 97% of the procedures were rated by surgeons as having a positive outcome. Across all regions, 54% of patients had no nodules or contracture after the procedures. Only 2% of patients required retreatment within the first year of surgery. Important inter- and intraregional differences in these aspects of patient management are described. **Conclusions:** Understanding current regional treatment patterns and their relationships to country-specific health systems may facilitate earlier identification of, and intervention for, DD and help to optimise the overall treatment for patients with this chronic condition.

### What's known

Many small, clinic-based studies have evaluated different procedures for and the outcomes of surgery for DC. Recently, the overall results from a large, two-part European study were reported. Across the region, fasciectomy was the most commonly performed procedure, and most surgeons were satisfied with the outcome. Fifty-four per cent of patients had no contracture postsurgery. Complication rates, recovery time and time away from work increased with invasiveness of the procedure.

### What's new

In the above-mentioned study, data from 12 countries were pooled to provide a broad overview of the findings. We conducted a regional analysis of the data and describe region- and country-specific variables related to procedures performed, outcomes and follow-up care. Identifying 'best practices' for diagnosing and treating patients with DC is important as the prevalence of DD is increasing, whereas healthcare resources are decreasing.

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### Disclosure

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## Introduction

Fixed-flexion contractures in patients with Dupuytren's disease (DD) are generally treated surgically to release or remove the cord(s) and to restore hand function. However, surgical correction is not a cure, and recurrence and/or extension of contracture is common. The most frequently used procedures for Dupuytren's contracture (DC) are fasciotomy (aponeurotomy), fasciectomy (aponeurectomy) and dermofasciectomy. In Europe, the treating physicians are typically orthopaedic surgeons or plastic surgeons and some are hand surgeons.

Although there have been many small-scale, country- or clinic-specific studies of surgical interventions for DC in Europe, there has not been a study large

enough to evaluate potential inter-country differences in the management of patients with DC until recently. To wit, the results of a large, two-part study designed to identify and describe the patterns of disease presentation and surgical management of DD across Europe were published (1,2). These articles report the Europe-wide findings; here, we report a regional analysis of the data to explore the regional differences in the presentation and surgical management of DD. In our first report, we focused on findings related to disease presentation, referral patterns and resource utilisation (3). In this article, we focus on findings related to the procedures performed, outcomes and follow-up care. Understanding the preferences and practices that surgeons use to treat various hand conditions, including DC, is important

in light of the prevalence of DD and ever-dwindling healthcare resources. It may be possible to modify some traditional approaches to the management of DD by identifying and implementing some 'best practices'. In turn, these endeavours may facilitate early identification and intervention, optimise the treatment outcome and reduce recovery time among patients with DC.

## Material and methods

Twelve European countries were selected to represent geographic variations in Europe, and the country-specific data were grouped into four regions: Nordic (Denmark, Finland, Sweden); East (Czech Republic, Hungary, Poland); West (France, Germany, the Netherlands, the UK); and Mediterranean (Italy, Spain). Orthopaedic and plastic surgeons from 12 European countries were randomly selected to participate. Surgeons who regularly treat patients with DD were identified via telephone and hospital directories, Internet sites and other clinical contacts. To be eligible, surgeons must have been practicing for 3–30 years. They were required to have surgically treated more than five patients with DC between September and December 2008. They were also required to have used more than two of the following procedures: percutaneous needle fasciotomy (PNF); fasciotomy (subcutaneous or open); fasciectomy (limited, local, partial, regional, selective, segmental, subtotal, total); and dermofasciectomy.

Surgeons responded to a questionnaire either online or in a face-to-face interview. The survey contained 15 questions assessing the type of procedure performed, waiting lists, recommended time away from work, factors involved in the decision to use a procedure, time to conduct the procedure, outcome of the procedure, follow-up care and recurrence. Surgeon satisfaction was assessed on a 7-point scale ranging from 1 (totally dissatisfied) to 7 (totally satisfied). Surgeons considered a list of attributes for each procedure and based their responses on patients with DC they had treated during the previous 12 months. Details of the study design and methods are published (2).

To be included, patients must have been diagnosed with DD and have undergone a procedure for DC during the 4-month period between September and December 2008. The procedure must have been performed by an orthopaedic or plastic surgeon; hand surgeons were included in each of these groups. There were no exclusion criteria. The 54-item questionnaire (Data S1) assessed patient demographics, referral history, diagnosis history, procedure performed, intra- and postoperative complications,

outcomes and follow-up. The questionnaire was translated into the local language of each country. Details about the study design and methods are published (1). Here, we present results related to the surgical procedures performed, outcomes and follow-up care. All data were summarised using descriptive statistics; means and standard deviations (SDs) were used for continuous variables and percentages for categorical variables.

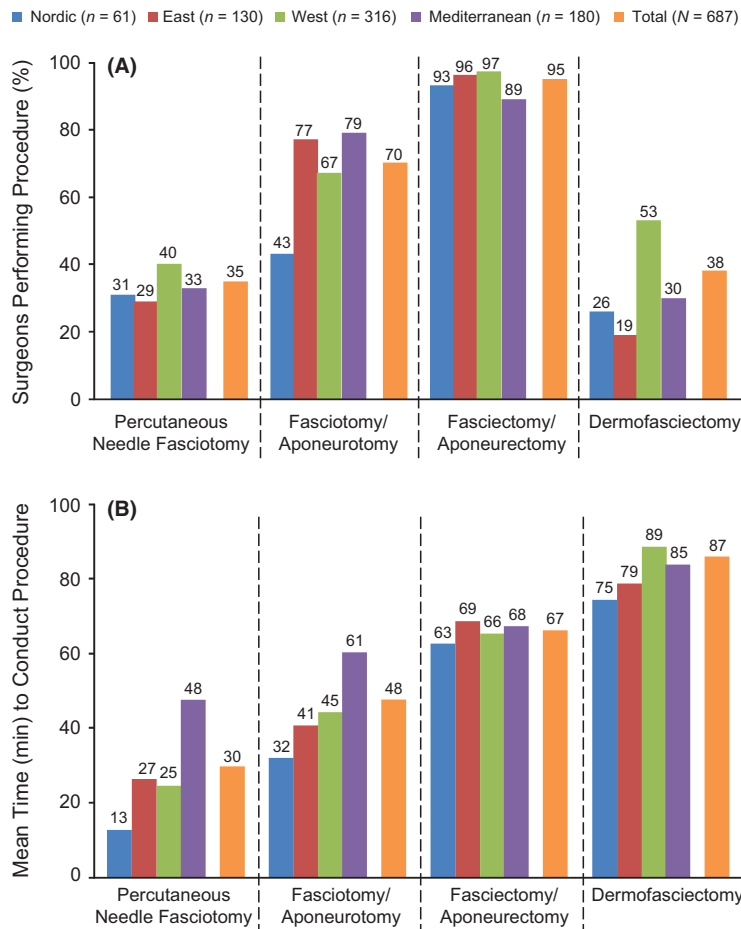
## Results

### Surgeon survey

In total, 687 surgeons were surveyed. Nearly half of the participants (46%) were practicing in the West; 26% in the Mediterranean, 19% in the East and 9% in the Nordic region. For the 12-month period surveyed, nearly all surgeons in all regions used fasciectomy for DC, followed by fasciotomy, dermofasciectomy and PNF (Figure 1A). There was greater regional variation in the use of fasciotomy and dermofasciectomy; the use of PNF was consistently low across regions. Notably fewer Nordic surgeons used fasciotomy; more Western surgeons used dermofasciectomy. Overall, the time required to perform the procedure increased with the level of invasiveness (Figure 1B). Nordic surgeons took less time to perform all procedures compared with surgeons in the other regions. Mediterranean surgeons took more time to perform PNF and fasciotomy compared with surgeons overall.

Most surgeons in all regions were generally satisfied with the fasciectomy procedure; on the 7-point Satisfaction Scale, they responded as being 'satisfied' or 'very satisfied'. About half of the surgeons were satisfied with the other procedures. A larger percentage of Nordic surgeons were satisfied with PNF compared with the other regions (Figure 2A). Specifically, most surgeons in all regions were satisfied with the restoration of finger function and improvements in range of motion obtained by fasciectomy; far fewer surgeons were satisfied after the other procedures. A larger percentage of Nordic surgeons were satisfied with restoration of finger function and improvements in range of motion after PNF in comparison with surgeons in the other regions (Figure 2B). There was some regional variation in general surgeon satisfaction with fasciotomy. In general, satisfaction rates for dermofasciectomy were relatively low and consistently so across all regions (Figure 2A and B).

Surgeons recommended that patients take more time away from work after more invasive procedures. The recommended mean  $\pm$  SD times were  $2.9 \pm 2.5$  weeks for PNF,  $4.6 \pm 2.7$  weeks for fasci-



**Figure 1** Surgeon survey results: procedures performed (during a 12-month procedure) by surgeons (A) and mean time spent per procedure (B) by region and procedure

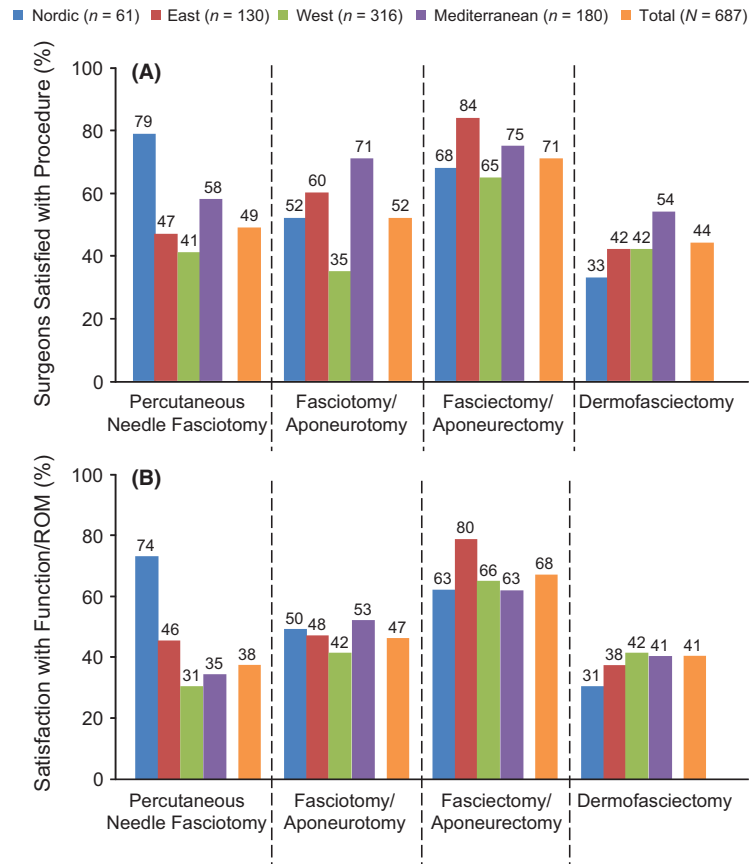
otomy,  $5.5 \pm 2.7$  weeks for fasciectomy and  $6.3 \pm 3.2$  weeks for dermofasciectomy. In the Nordic region, the recommended times away from work were lowest for all procedures, ranging from 0.95 weeks for PNF to 5.6 weeks for dermofasciectomy. In the East and Mediterranean regions, recommended times away from work were highest for all procedures, ranging from 3.9 to 4.1 weeks respectively for PNF and 8.4 and 7.4 weeks respectively for dermofasciectomy.

The majority of patients had physical therapy (PT) after any procedure for DC, and there was little regional variation in the use of PT after fasciotomy, fasciectomy and dermofasciectomy. For PNF, 82% of patients had PT overall; however, the percentages for the East, West and Mediterranean regions were 90%, 84% and 98% respectively. In the Nordic region, only 11% of patients had PT after PNF. The mean times to start of PT were comparable across procedures (range, 2.0–2.6 weeks) and consistent across regions (range, 1.9–2.9 weeks). The mean duration of PT increased with invasiveness of

the procedure: 5.2 weeks for PNF, 5.3 weeks for fasciectomy, 6.7 weeks for fasciectomy and 8.5 weeks for dermofasciectomy. Mean PT durations were fairly consistent across regions. In the Nordic region, PT was shorter vs. overall (2.0 vs. 5.2 weeks) for PNF and longer for fasciectomy (9.6 vs. 6.7 weeks) and dermofasciectomy (14.7 vs. 8.5 weeks). The majority of patients in all regions received PT at least once a week regardless of procedure used.

### Patient chart review

Data were extracted from 3357 evaluable patient charts. Patient demographics and clinical characteristics are presented in detail in our companion article (3). Briefly, 90% of all patients were aged 50 years or older and 81% were men. In the East, West and Mediterranean regions, 50% of patients had fixed-flexion contractures  $> 45^\circ$  (Tubiana stages II–IV) at diagnosis; in the Nordic region, 70% of patients had contractures of this severity. Although the duration of time between diagnosis and surgery was long



**Figure 2** Surgeon satisfaction with procedure (A) and restoration of finger function and range of motion (B) by region and procedure. On a 7-point scale, values represent the percentage of surgeons that responded as 'Satisfied' (6) or 'Very satisfied' (7). ROM, range of motion

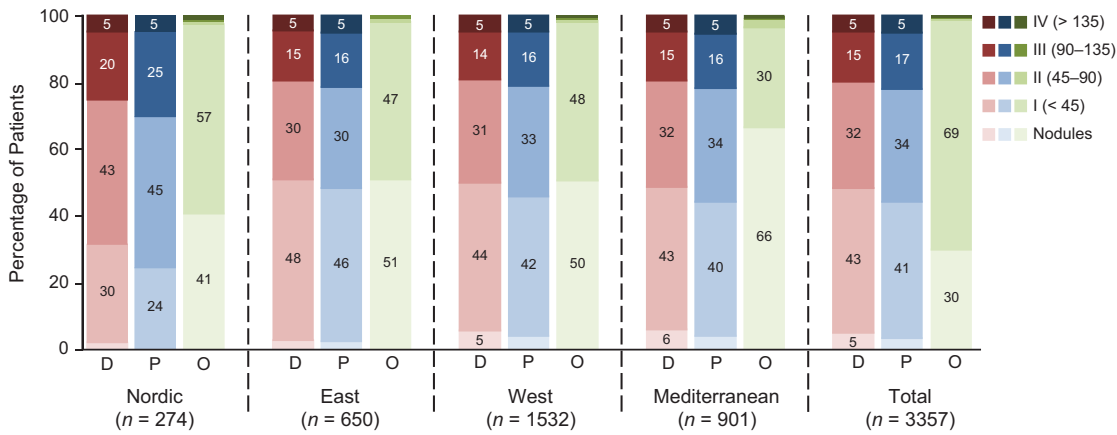
(30 months overall) (3), in all regions there was little change in contracture severity during this interval. Furthermore, the distributions of patients by severity rating at both time points were virtually identical in the East, West and Mediterranean regions. In contrast, in the Nordic region, there were notably more patients with Tubiana stages II (45–90°) and III (90–135°) compared with the other regions and overall (Figure 3). There was no relationship between disease severity and time from diagnosis to referral or from referral to surgery (data not shown).

During the 4-month period between September and December 2008, the records' review revealed that most DC procedures were fasciectomies, followed by fasciotomies, PNFs and dermofasciectomies (Figure 4A). Owing to the relatively low use of procedures other than fasciectomy, there were few regional differences; however, in the Mediterranean region, more surgeons performed fasciotomy and fewer performed fasciectomy vs. overall. The time required to perform the surgery increased with invasiveness of the procedure (Figure 4B). Nordic surgeons took less time to perform PNF compared with

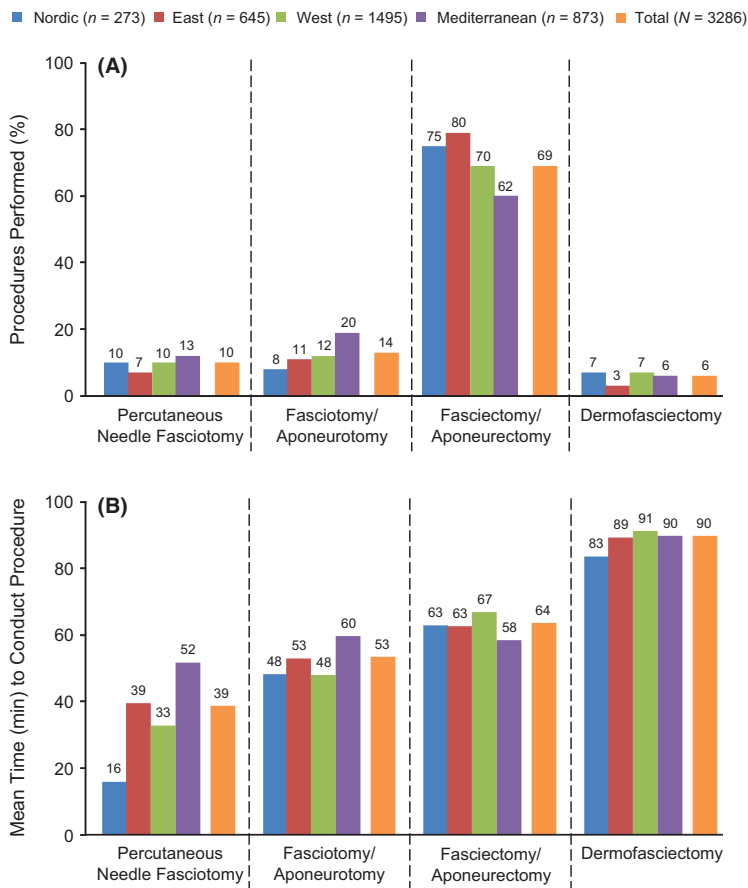
surgeons from other regions. Surgeons in the Mediterranean region took more time to perform PNF and fasciotomy in comparison with other regions.

In the Nordic region, 10% of all procedures were PNFs, which was identical to the overall percentage; however, the use of PNF was markedly different among the Nordic countries (Figure 5). Similarly broad ranges in the use of PNF were also observed in the West and Mediterranean regions. In the East, twice as many Polish surgeons performed fasciotomy as Hungarian surgeons and only 4% of Czech surgeons used fasciotomy. For dermofasciectomy, nearly twice as many Finnish surgeons used this procedure than other surgeons from all other participating countries (Figure 5).

Overall, procedures were most often performed on contractures of the ring (39%) and little fingers (36%). There was little regional variation in the proportion of ring fingers that underwent surgery (range, 37–42%). However, the percentage of little fingers that underwent surgery was larger in the Nordic region (46%) vs. overall (36%). For the middle



**Figure 3** Severity of contracture at diagnosis and pre- and postsurgery by region. D, at diagnosis; P, at time of the procedure; O, outcome



**Figure 4** Chart review results: procedures performed by surgeons (A) and mean time spent per procedure (B) by region and procedure during a 4-month period

and index fingers, the proportions operated on increased from the Nordic to Mediterranean regions (middle: 12–19%, index: 2–8%). Only a small percentage of procedures were performed on thumbs (overall, 3%; range, 2–4%).

The complication rate during surgery for DC was 4.0%; reported rates were highest in the Mediterranean region and lowest in the East (Table 1). Overall and across all regions, the rate of complications during the procedure was highest for fasciectomy

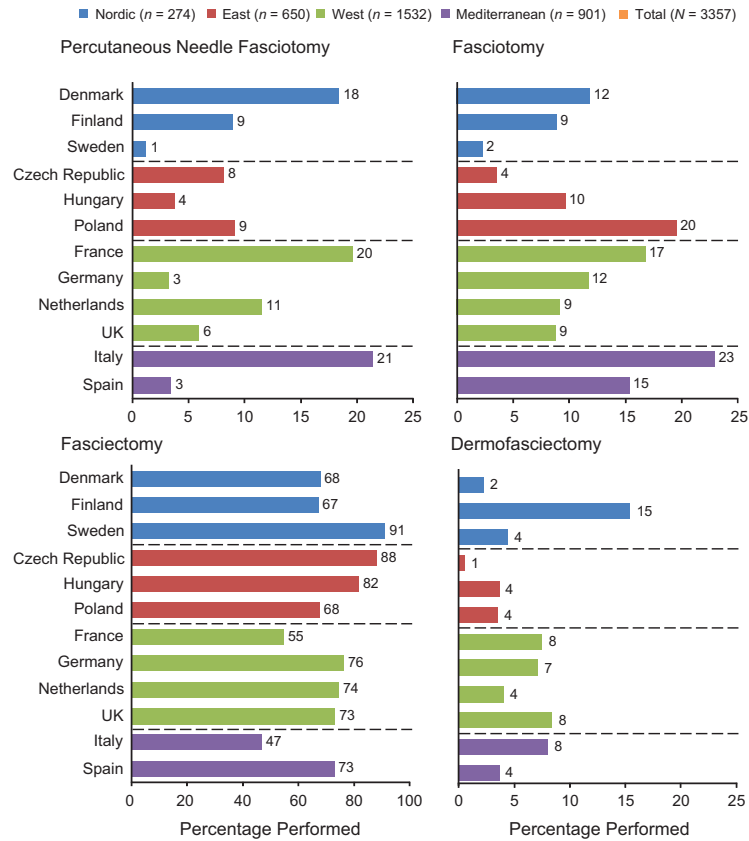


Figure 5 Chart review results: procedures performed by region, country, and type of procedure

(Figure 6A). During fasciectomy, 55% of all complications were nerve injuries, followed by arterial (24%) and then volar plate injuries (15%) (Table 2). Only two patients had intra-operative bleeding: one during fasciotomy and one during fasciectomy. Only one patient experienced ischaemia, which occurred during fasciectomy (Table 2). Nerve injury was the most frequent complication overall; rates were higher in the Nordic and East regions. With the exception of the Mediterranean region, volar plate injuries were infrequent. Tendon injuries were also rare (Figure 6B).

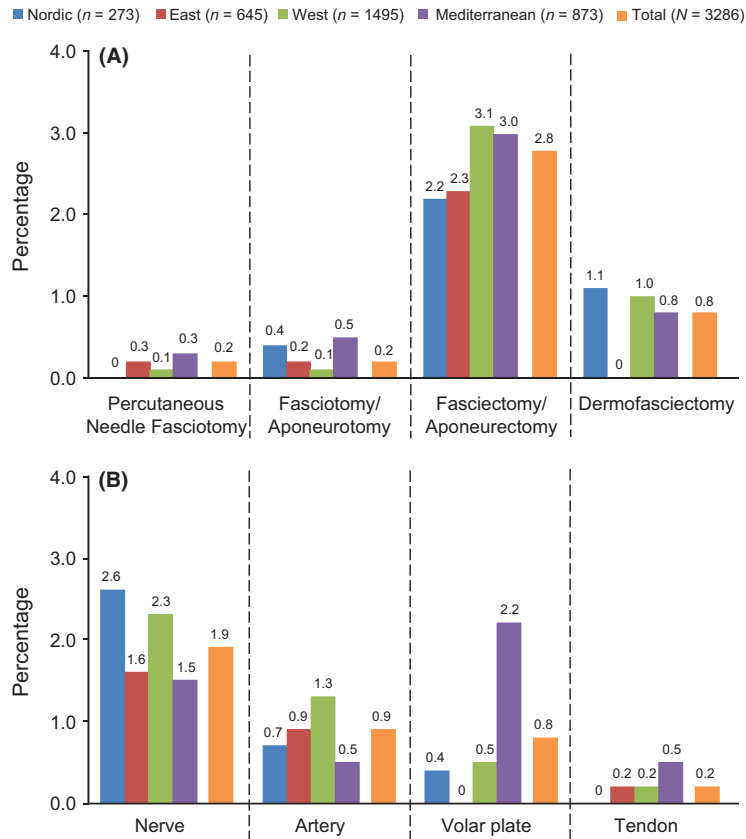
The complication rate after surgery for DC was 34% overall; rates were highest in the Mediterranean region and lowest in the Nordic region (Table 1). By procedure, postoperative complication rates were highest for fasciectomy (Figure 7A). After fasciectomy, 27% of all complications were haematomas, followed by delayed healing (19%) and pain (17%). Haematoma was the most common complication after PNF (36%) and delayed healing was the most common complication after dermofasciectomy (26%). Pain was the most frequent complication after fasciotomy (30%; Table 2). Postoperative complications by region and type of event are shown in Figure 7B. Complications that occurred in  $\leq 2\%$

Table 1 Intra- and postoperative complications by region and procedure

| Region                  | During procedure |              | After procedure |              |
|-------------------------|------------------|--------------|-----------------|--------------|
|                         | Events (n)       | Rate (%)*, † | Events (n)      | Rate (%)*, † |
| <b>Region</b>           |                  |              |                 |              |
| Nordic (n = 273)        | 10               | 3.7          | 74              | 27.1         |
| East (n = 645)          | 18               | 2.8          | 252             | 39.1         |
| West (n = 1495)         | 65               | 4.3          | 395             | 26.4         |
| Mediterranean (n = 873) | 40               | 4.6          | 392             | 44.9         |
| <b>Procedure</b>        |                  |              |                 |              |
| PNF                     | 7                | 2.6          | 25              | 0.8          |
| Fasciotomy              | 8                | 1.2          | 108             | 3.3          |
| Fasciectomy             | 93               | 6.2          | 834             | 25.4         |
| Dermofasciectomy        | 25               | 2.9          | 146             | 4.4          |
| Total                   | 133              | 4.0          | 1113            | 33.9         |

\*Calculated by dividing the number of events by the number of patients in each region. †Calculated by dividing the number of events by the total number of patients in all regions (n = 3286).

PNF, percutaneous needle fasciotomy.

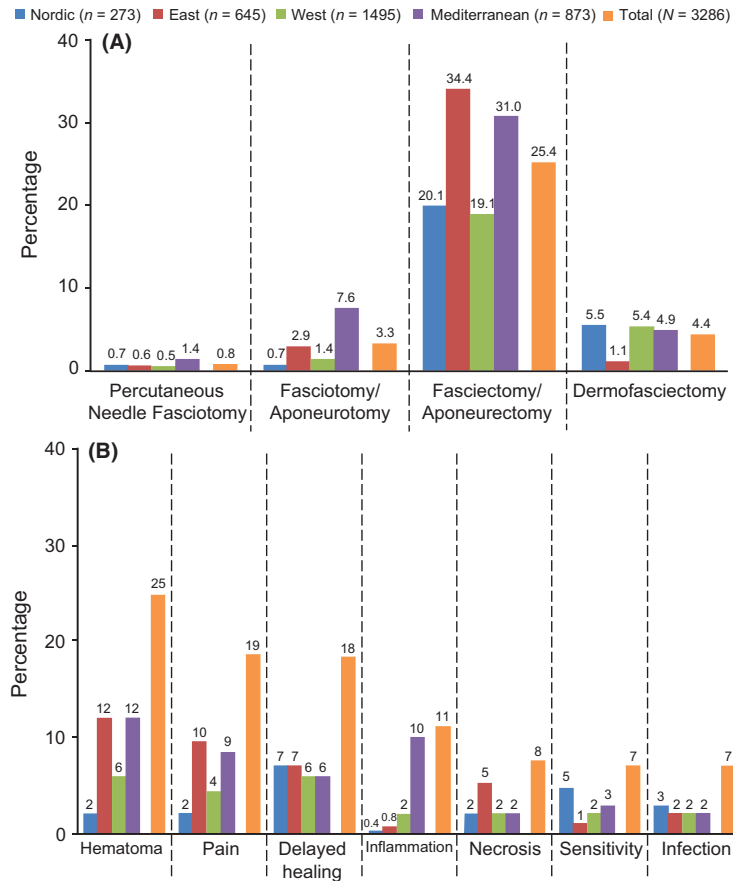


**Figure 6** Intra-operative complications (A) by procedure and (B) by type of event

**Table 2** Intra- and postoperative complications by procedure and type of injury

| Injury                              | PNF      | Fasciotomy | Fasciotomy | Dermofasciotomy | Total      |
|-------------------------------------|----------|------------|------------|-----------------|------------|
| <b>Intra-operative</b>              |          |            |            |                 |            |
| Nerve                               | 1 (14)   | 2 (25)     | 51 (55)    | 10 (40)         | 64 (48)    |
| Arterial                            | 3 (43)   | 1 (13)     | 22 (24)    | 5 (20)          | 31 (23)    |
| Volar plate                         | 2 (29)   | 4 (50)     | 14 (15)    | 7 (28)          | 27 (20)    |
| Tendon                              | 1 (14)   | 0 (0)      | 4 (4)      | 3 (12)          | 8 (6)      |
| Bleeding                            | 0 (0)    | 1 (13)     | 1 (1)      | 0 (0)           | 2 (2)      |
| Ischaemia                           | 0 (0)    | 0 (0)      | 1 (1)      | 0 (0)           | 1 (1)      |
| Total                               | 7 (100)  | 8 (100)    | 93 (100)   | 25 (100)        | 133 (100)  |
| <b>Postoperative</b>                |          |            |            |                 |            |
| Haematoma                           | 9 (36)   | 21 (19)    | 226 (27)   | 20 (14)         | 276 (25)   |
| Pain                                | 7 (28)   | 32 (30)    | 142 (17)   | 27 (19)         | 208 (19)   |
| Delayed healing                     | 2 (8)    | 10 (9)     | 155 (19)   | 38 (26)         | 205 (18)   |
| Inflammation                        | 2 (8)    | 24 (22)    | 76 (9)     | 23 (16)         | 125 (11)   |
| Necrosis                            | 0 (0)    | 2 (2)      | 67 (8)     | 16 (11)         | 85 (8)     |
| Infection                           | 2 (8)    | 9 (8)      | 54 (7)     | 8 (6)           | 73 (7)     |
| Allodynia/dysaesthesia/paraesthesia | 0 (0)    | 5 (5)      | 63 (8)     | 11 (8)          | 79 (7)     |
| Total                               | 25 (100) | 108 (100)  | 834 (100)  | 146 (100)       | 1113 (100) |

Values represent n (%). Values may not sum to 100% owing to rounding error. PNF, percutaneous needle fasciotomy.



**Figure 7** Postoperative complications (A) by procedure and (B) by type of event

patients included complex regional pain syndrome, amputation, carpal tunnel syndrome, delayed bleeding and swan neck deformity.

Postoperatively, a bulky bandage was the most frequently used dressing (49%); this percentage was higher in the Nordic region (74%). The mean  $\pm$  SD duration of bandage/splint use was  $10.2 \pm 9.0$  days. Night splints were used by 41% of patients overall; usage was higher in the West region (52%). Although a comparable percentage of Nordic patients used night splints (41%) vs. overall, the mean  $\pm$  SD duration of use was more than twice as long ( $65.7 \pm 51.3$  days) vs. overall ( $32.2 \pm 38.1$  days). In general, however, there was great intraregional variation in the duration of use of postoperative bandages and splints.

Overall, most patients were managed postoperatively by the operating surgeon or a physiotherapist/occupational therapist. There was little regional variation with the exception of the West region, where a larger percentage of patients (24%) was managed by a general practitioner vs. overall (15%). Overall,  $\geq 97\%$  of the procedures were rated by the surgeon as having a positive outcome. Methods for evaluating

effectiveness included finger flexion or extension (56%), functional ability (45%) and table-top test (17%). Larger percentages of surgeons in the East region assessed flexion or extension (66%) and functional ability (60%); fewer surgeons in the Nordic region used a table-top test (4%) vs. overall.

Across all regions, 54% of patients had no nodules or contracture after the procedure; this number was higher for Mediterranean (66%) and lower (41%) for Nordic patients. As reflected by the Tubiana staging system, there was a shift towards less severe contracture after the procedure. Overall, the mean  $\pm$  SD number of clinic visits after the procedure was  $3.8 \pm 2.1$ , ranging from  $2.0 \pm 1.8$  in the Nordic region to  $3.6 \pm 2.1$  in the West and  $4.4 \pm 2.2$  in the East and  $4.4 \pm 1.9$  in the Mediterranean. The mean  $\pm$  SD time to recover optimum hand function was  $2.9 \pm 1.8$  months overall and there was little regional variation. The majority of patients (78%) recovered hand function in  $\leq 3$  months. Overall, only 2% ( $n = 82$ ) of patients required a second surgery within the first year after the procedure; comparable numbers of patients had recurrence ( $n = 27$ )



and disease extension to other joints ( $n = 32$ ). Overall, the mean  $\pm$  SD time between the first and second procedures was  $8.4 \pm 4.4$  months; this interval was shortest in the East ( $6.3 \pm 4.4$  months) and longest in the West ( $9.4 \pm 3.2$  months).

## Discussion

In this large, two-part study of the management of DD in Europe, 12 countries participated, nearly 700 surgeons were surveyed, and more than 3350 patient charts were reviewed. The amount of data collected is substantial, and the first two reports of the study findings provided a broad overview of aspects of DD management using data that were combined across the 12 countries (1,2). In our companion article (3), we provided an in-depth assessment of region- and country-specific data for patterns of disease presentation and diagnosis, patient demographics and resource utilisation. Here, we present detailed results relating to the procedures performed, including frequency of use and duration; complications during and after surgery; and postoperative care, follow-up and outcome.

In this study, virtually all participating surgeons (95%) performed fasciectomy for DC during the 12 months before the survey. Seventy per cent performed fasciotomies and 38% each performed dermofasciectomy and PNFs. In a systematic review of the efficacy and safety of fasciectomy and fasciotomy for DC, Crean et al. (4) reported that of the evaluable studies, 88% of the treatment groups represented fasciectomy; of this total, 14% were dermofasciectomy. Only 12% evaluated fasciotomies; all, but one evaluated PNFs (4).

Survey data also showed that the time to conduct a procedure increased with the level of invasiveness; times were shortest for PNF and longest for dermofasciectomy. It is likely that the duration of the procedure is more directly related to disease severity, as this is a major consideration when choosing a particular procedure to perform. This has been demonstrated previously (5). When the 12-month survey results were compared with the 4-month patient chart findings, there was a trend for surgeons to overestimate the number of procedures they performed and to underestimate the time required to perform them, even after accounting for the time interval difference. However, because the survey approach can be prone to recall bias, data extracted from patient charts may be a more robust approach and more reasonable representation of clinical practice.

It is difficult to compare outcomes of surgery for DC, as most studies define success or functional

improvement differently. In the Crean review (4), short-term efficacy (i.e.  $< 6$  months postprocedure) was evaluated as mean improvement in contracture, percentage of patients with full release and patient- or physician-rated satisfaction with the procedure and/or improvement in hand function. In the current study, surgeon satisfaction was highest after fasciectomy (71%) and lowest for dermofasciectomy (44%). In particular, a large percentage of Mediterranean surgeons were satisfied with fasciotomy (71%), and a large percentage of Nordic surgeons were satisfied with PNF (79%).

Surgeon satisfaction with improvements in range of motion and restoration of finger function after fasciectomy was 68% overall; however, satisfaction rates were highest among Eastern surgeons after fasciectomy (80%) and among Nordic surgeons after PNF (74%). This is not unexpected, as surgeons typically obtain better outcomes after procedures they perform most often and do well. Inversely, lower satisfaction rates with dermofasciectomy may not be the result of the procedure *per se*, but because of the greater severity of disease dictating its use. In the Crean review, the overall mean for the studies evaluating surgical success was 75% (range, 61–85%) (4). In the current study, there was a shift from more severe to less severe Tubiana stages; at least 41% of all patients had no nodules or contractures after their procedures.

In Denkler's systematic review of complications after fasciectomy (6), the types and frequency of intra-operative events were far fewer than postoperative events. Intra-operative digital artery and nerve injuries were most common (2% and 3% respectively). These rates are comparable with this study, in which the intra-operative complication rate for fasciectomy across regions was 2.8%. Of this total, arterial and nerve injuries comprised the largest percentage (73%). Bulstrode et al. (7) compared the intra-operative complication rate for nerve injury (2.0%) with rates from other studies (range, 1.5–7.8%). In Bulstrode et al.'s review, the arterial injury rate was 0.8%; rates from other studies ranged from 0.8% to 9.8% (7). Postoperatively, the highest rates included wound-healing complications (23%), incision scar pain (17%), dysaesthesia or paraesthesia (14%) and hypoesthesia (10%) (6). Among the studies reporting haematoma as a postoperative complication, the average rate was 2% (6). In Bulstrode, the rates for haematoma ranged from 0% to 15.8% (7). In contrast, in the current study, haematoma was the most common postoperative complication (27%). However, delayed wound-healing (19%) and pain (17%) were also frequently reported. In one report of semi-structured interviews of patients with DD,

several individuals had self-reported pain postoperatively, which influenced their decisions regarding further treatment of other fingers (8).

As might be expected, the recommended time away from work and duration of PT increased with the invasiveness of the procedure. However, there were notable regional differences. Nordic surgeons recommended the shortest leave of absence from work for all procedures ( $\leq 5.6$  weeks); surgeons in the East and Mediterranean regions recommended the longest leave of absence ( $\leq 8.4$  weeks). These variations are likely the result of inter-country differences in health systems, particularly with regard to resource availability and allocation. For the patient, the direct costs of healthcare and indirect costs associated with lost productivity will increase with the severity of contracture at the time of the procedure as well as with the complexity of the procedure itself. These associations were demonstrated in a study of injuries to the hand and forearm and how these events affect costs, hand/arm function and general health (9).

The rate of recurrence or extension in this study was extremely low (2%), likely because the time period of interest for the survey and chart review was relatively short, ranging from 12 to 15 months. Recurrence rates are highly dependent on the duration of, and loss to, follow-up as well as the definition of recurrence, which is often different (or left undefined) in studies of surgical outcomes for DC (10,11). In the Crean review (4), the mean time to recurrence after a fasciectomy was 3–4 years. In another systematic review of studies using open partial fasciectomy, PNF and collagenase *Clostridium histolyticum* (CCH) injection, follow-up times ranged from 6 weeks to more than 7 years (11). For open partial fasciectomy, recurrence rates ranged from 0% to 39% after 1.5–7.3 years of follow-up. For PNF, 50% of patients had recurrence after 6 weeks to 5 years. For CCH, rates ranged from 10% to 31% after 4 months to 4 years (11). Rates after open partial fasciectomy were significantly lower than were rates after PNF ( $p = 0.001$ ) and significantly higher than those after CCH ( $p = 0.001$ ) (11).

The results from this study should be interpreted in light of some limitations. First, the findings have been reported descriptively, not inferentially. Thus, they can only be used to generate hypotheses and to help define research objectives for further study. As mentioned, the survey is prone to recall bias, and the quality of the chart data is only as good as the clarity and completeness of the questionnaire as well as the accuracy with which the data were extracted from the records.

To conclude, novel data from hundreds of surgeons and thousands of patients in Europe were used to identify and characterise regional differences and similarities in the surgical management of DC, including the type of procedures performed, outcomes and follow-up care. Understanding current treatment patterns and their potential relationships to country-specific health systems and economics may facilitate earlier identification and intervention for DD and help to optimise the management plan for patients with DC.

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## Author contributions

C Bainbridge, JC Cappelleri, J Dias, LB Dahlin, D Guerin, RA Gerber, and C Leclercq were responsible for the concept and design of the manuscript. D Guerin collected the data and performed the statistics. JC Cappelleri, LB Dahlin, J Dias, RA Gerber, D Guerin and PP Szczypa analysed and interpreted the data. C Bainbridge, JC Cappelleri, LB Dahlin, J Dias, RA Gerber, D Guerin, C Leclercq and PP Szczypa drafted, critically revised and approved the final manuscript.

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## Supporting Information

Additional Supporting Information may be found in the online version of this article:

**Data S1** Surgeon Survey Questionnaire.

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