

# A review of the classification of Dupuytren's disease

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## Abstract

Although much has been published about the treatment of Dupuytren's disease, there is no clear consensus regarding the most effective form of treatment. Part of this uncertainty may result from the absence of a universal method of assessing this condition. We undertook a review of the literature in order to summarize the various methods by which Dupuytren's disease has been measured and quantified. We included all articles that offered a classification or assessment system for the disease. We excluded articles that dealt solely with surgical technique (although inevitably there was some overlap). We conclude that there are many methods of assessment, but that none of them is perfect and that further work is needed in the field.

## Keywords

Dupuytren's disease, classification, scoring, assessment

## Introduction

Much has been written about the treatment of Dupuytren's disease. There is, however, a lack of standardization of the recording of data in these patients. Consequently, 'the critical comparison of techniques or results is impossible due to major inconsistencies in reporting' (Becker and Davis, 2010). We undertook a review of the literature using an Embase and Medline search in order to summarize the various methods by which Dupuytren's disease has been classified. Our search strategy included the terms 'Dupuytren', 'Dupuytren's', 'Dupuytren disease', 'Dupuytren's disease'. We searched from 1930 to the end of 2013.

We reviewed all of the articles chosen to assess if there was any form of classification included. Articles that described, for instance, a surgical technique in isolation were excluded. Articles that described a surgical series and then classified the results by means of a scoring system were included, even if the article was not specifically designed to offer a surgical classification system. Because we were keen to include as many classifications as we could, and because we were not looking for the results of the surgical trial itself, we did not feel that it was necessary to stratify the articles according to the Coleman criteria.

A word is indicated about terminology. Inevitably there is some overlap between the various terms that one might use. We have used the term *assessment* to define an aspect that one might measure, e.g. degree of contracture, type of disease. We have used the term *scoring system* for any system that has attempted

to quantify the disease by producing a series of numbers or discrete variables. Thus, an assessment may show that the contracture at a proximal interphalangeal (PIP) joint is 45°, and a related scoring system may allocate 2 points because this falls into an arbitrary band of contractures of between 30° and 60°. Sometimes these individual scores will be summed to give an overall score. Sometimes these will reflect a quantification of a method of assessment. We have used the term *classification* to describe subdivision into separate types that are not ordinal, for instance a histological classification. Both the classifications and the scoring systems seemed naturally to fall into a number of different sub-types, and we have ordered the articles accordingly. There is no scientific rationale about this, simply that we felt that ordering the articles in this way would allow different aspects of the disease patterns to be approached by the group.

## Methods of assessment

### *Degree of contracture*

The severity of contracture and the total range of motion of the affected joints may be measured using

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a goniometer. This may be easily carried out in clinic. The equipment required is cheap, easy to use and widely available. Computerized goniometry has also been described, but the effect on measurements has been found to differ little from standard goniometry (Georgeu et al., 2002). Visual estimation has been found to be less accurate than measurement using a goniometer (Rose et al., 2002).

### *Type of disease*

Sennwald (1990) recognized that the evaluation of Dupuytren's contractures based purely on the degree of digital flexion deformity was insufficient, as the severity of contracture did not necessarily reflect the severity and extent of the disease itself. He therefore suggested that the disease should be staged based on the localization of 'pathologic fascia' that would reflect the degree of difficulty at the time of surgery.

### *Histology*

The use of histology to assess Dupuytren's disease has been described by various authors. Anderson (1891) first reported the concept of cellularity and abnormal deposition of collagen within tissue affected by Dupuytren's disease. He also noted the heterogeneity of samples, not only between individuals, but also within individuals. Meyerding et al. (1941) suggested that histological findings could predict the rate of recurrence following surgery.

Luck (1959) described a histological staging system that classified the disease into three progressive stages: a proliferative stage characterized by intense cellularity randomly arranged in separate whorls; an involutinal stage in which cells appear to align themselves along lines of tension; and a residual stage in which the tissue is largely acellular and fibrous. Luck was also the first to establish the 'nodule' as the primary lesion of Dupuytren's disease, and that it subsequently transformed into a 'cord'. Luck's staging system relied on simple histological techniques and traditional stains providing a low cost and reproducible staging system (Lam et al., 2010). Gokel and Hubner (1977) used the electron microscope to examine the cell morphology in different Luck stages and found that the myofibroblast was the predominant cell type in the involutinal phase. Meister et al. (1979) found different proportions of Type III and I collagen and were able to correlate this to Luck's staging system.

Several authors have since attempted to modify or refine Luck's system: Chiu and McFarlane (1978) and subsequently Rombouts et al. (1989) reported a positive correlation between histological findings and

recurrence rate based on modifications of Luck's classification. Rombouts described three different histological types of Dupuytren's disease: proliferative disease with a high cellularity and mitosis (Type I); fibrocellular disease characterized by the presence of a reticulin network (Type II); and fibrous disease with few cells (Type III). Any biopsied Dupuytren's disease tissue will demonstrate a mixture of these types, and the authors graded their cases according to the lowest grade found. They believed that the risk of recurrence was greatest with Type I and lowest with Type III disease. There was found to be no correlation with the risk of extension of Dupuytren's (Rombouts et al., 1989). The validity of Rombout's classification in predicting recurrence was subsequently reaffirmed by Balaguer et al. (2009). McGrouther (1999) reported that by reducing Luck's original three stages to two, it was possible to incorporate the biomechanical processes known to act in Dupuytren's disease with Luck's system to produce a two-stage process: an initial proliferative process; and a later mechanical process. Lam et al. (2010) extended Luck's system by quantifying the collagen ratios together with cellularity of the tissue based on the relative amount of Type III collagen in each stage. Gelberman et al. (1980) reported an apparent correlation between the presence of myofibroblasts or prominent microtubules in biopsied Dupuytren's tissue and the risk of recurrence.

None of these assessments is of any pre-operative value.

### *Presence of predisposing conditions*

Several conditions are believed to increase the risk of developing Dupuytren's disease, and the presence or absence of these should be sought as part of the clinician's assessment of the patient. Hueston (1963) introduced the concept of Dupuytren's 'diathesis', a permanent condition of the body that renders it liable to certain special diseases (The Shorter Oxford English Dictionary). Hueston's diathesis alluded to certain characteristics of the disease that dictated an aggressive course and greater tendency for recurrence after surgical treatment. He described four factors as part of the diathesis: bilateral disease (described as bilateral palmar lesions); family history of Dupuytren's; ectopic lesions (found outside the palmar surface); and age at onset of disease. Hueston noted that patients developed recurrence more frequently than extension. (Recurrence is defined as the development of new Dupuytren's disease tissue within the area of previous surgery. Extension is defined as the development of new Dupuytren's disease tissue away from the original surgical site.)

Whether the development of disease in the same digit many years later actually represents recurrence or whether it represents 'new disease' arising from previously undiseased fibres raises further uncertainty about the definition of the recurrence of Dupuytren's. Later it was proposed that the presence of diathesis indicated degree of disease severity or aggressiveness (in other words the disease is likely to progress more rapidly and cause more severe contractures) and may predict postoperative outcome (Hindocha et al., 2006).

Although the literature is not always consistent, other factors have been reported as being associated with Dupuytren's, including a history of smoking (Burge et al., 1997), alcohol abuse (Noble et al., 1992), frozen shoulder (Smith et al., 2001), epilepsy (Arafa et al., 1992), diabetes mellitus (Noble et al., 1984), history of manual labour (Bennett, 1982), vibration exposure (Liss and Stock, 1996) and male gender (Lanting et al., 2014). Although none of these factors were included in the original diathesis described by Hueston, they may also be associated with the development of recurrent disease (Hindocha et al., 2006). Conversely rheumatoid arthritis sufferers may have a lower incidence of Dupuytren's (Arafa et al., 1984).

Abe et al. (2004a) studied risk factors including diabetes, radial side of hand involvement, little finger disease, ectopic lesions, family history, gender, early onset of disease (before age 45) and epilepsy. Of these factors, they reported that only radial-sided disease and ectopic lesions correlated with recurrence. Although they believed there to be an increased risk of recurrence in patients with a diathesis, they were unable to prove this statistically.

### *Assessment of hand function*

Numerous systems have been proposed for the assessment of hand function. Of these, only the Unité Rhumatologique des Affections de la Main (URAM) system has been validated for the assessment of Dupuytren's disease. This is a nine-item, patient-reported functional measure for Dupuytren's disease with good psychometric properties that can be used in daily practice and clinical studies. It is also short and thus easy to use. It has an associated disability range from 0 (best) to 45 (worst). A high score suggests a high level of disability (Beaudreuil et al., 2011).

Becker and Davis suggest, in their systematic review, that the Disabilities of the Arm, Shoulder and Hand (DASH) and Patient Evaluation measure (PEM) should form part of the assessment for Dupuytren's Disease in any future studies (Becker and Davis, 2010).

### *Rate of recovery/time to return to work*

The rate of recovery following surgery for Dupuytren's disease may also allow assessment of improvement in hand function following surgery. The time taken to return to work provides a finite end point. However, the time to return to work may not be influenced solely by the rate at which hand function improves following surgery. It may be affected by other factors, such as type of work (heavy manual work or office work), the flexibility of the employer in allowing the patient to return to lighter duties in a staged return to work such that they can return to work earlier, whether the patient is self-employed or not and the patient's desire to return to work.

### *Recurrence and progression*

Disease recurrence following surgery or extension, and the time taken from the date of surgery for either of these to occur, may influence the outcome. Although many studies use recurrence and extension as a marker for assessing their patients, it has been noted by Becker and Davis that the definition of recurrence varies between authors. Furthermore, some authors combine recurrence and extension as a single category. Becker and Davis (2010) attempted to clarify this and proposed that recurrence should refer to 'the presence of any Dupuytren's tissue in an area previously operated upon, which causes a contracture greater than that present after the previous surgery'. Extension refers to the development of disease outside the original surgical field (Becker and Davis, 2010).

Shaw et al. (1996) used a Kaplan-Meier survival curve to examine recurrence and the use of this is supported by Becker and Davis (2010). A Kaplan-Meier survival curve can be valid only if it has a clear end point. Many factors will influence the patient and surgeon in considering whether further surgery is indicated following recurrence or progression of Dupuytren's disease, and it is therefore debatable whether surgery is a sufficiently firm end point to be used as a marker of recurrence.

Recently, Westacott et al. (2014) have suggested a simple community-based progression monitoring of contractures by the patients themselves. The hand is painted with water soluble paint and placed as flat as possible on a sheet of paper, creating a permanent record for future comparison. When progression of contracture is noted, the patient can request an outpatient appointment to discuss treatment options.

### *Complications*

Almost all studies in the literature report their complication rates as part of their assessment. These

may include haematoma, nerve injury, complex regional pain syndrome (CRPS), infection or wound problems. There is, however, a significant variation in the detail in which specific complications are recorded. This point is made by Becker and Davis (2010), who highlight the inconsistency with which the outcomes of surgery are reported throughout the literature on Dupuytren's Disease and who call for future studies to report a minimum standardized data set. They propose that this minimum data set should include:

the mean and range of patient age; the number of patients, hands and rays operated upon; a clear and agreed definition of recurrence, minimum and narrow follow up intervals, rates of common complications and both objective and subjective measurements of operative outcome with the use of scoring questionnaires (e.g. DASH and PEM) and a standardized clinical examination including skin quality and range of movement measurements at 2, 6 and 12 weeks, and at 1 and 5 years. (Becker and Davis, 2010)

## Scoring systems

A review of the published literature over the past 100 years shows that many authors have attempted to score Dupuytren's disease. All have tried to bring a more scientific approach to analysing the disease, measuring its severity or assessing the outcome following surgery. Many use certain aspects of the methods of assessment that have been discussed earlier in this article as part of their scoring system. Some are relatively simple, while others are complex. The large variety of suggested systems implies that there is currently still no accepted standard for scoring in Dupuytren's disease.

The proposed scoring systems fall into five broad categories.

1. Severity according to the degree of contracture.
2. Detailed scoring of every digit.
3. Systems that score the severity of the condition or results of surgery into arbitrary categories of excellent/good/fair/poor.
4. Attempts to predict surgical difficulty.
5. Questionnaire based or functional assessment scores.

The earliest published description of a scoring system for Dupuytren's disease appears to be by Meyerding (1936). He offered a system based simply on the degree of deformity on pre-operative evaluation ranging from 0 (no deformity other than thickening of the palmar fascia) to 4 (contracture of all digits). Successive scores between these indicated progressive degrees of contracture and involvement of

increasing numbers of digits (Supplementary Table 1). Although Meyerding suggested this classification, he did not use it to classify his results in this article. Einarsson (1946) classified his results broadly according to Meyerding. He made some minor changes to Meyerding's original description of the stages: stage 3 in Meyerding's original description described contracture of two or more fingers and contracture of 90° or more of one, whereas Einarsson described 'grade 3' as flexion deformity of more than one finger, exceeding 60° in at least one (Supplementary Table 2). Interestingly, in the summary of same article, Einarsson then categorizes his results as either excellent, fair or poor, without describing a clear system for this and choosing to use this rather than the classification that he has described earlier in the article.

McIndoe, who had originally worked with Skoog in the 1940s, went on to publish his classification with Beare in 1958. In this article, McIndoe and Beare (1958) describes a four-stage system based on clinical progression (Supplementary Table 3). He stated that the results expected from surgery deteriorate as the disease progresses through each successive stage and advised that one should operate as early as possible, preferably before the patient has reached Stage 2 of his scoring system.

Davis (1965) outlined his postoperative results using four categories, which he described as good/fair/poor/bad. He proposes a scoring system based on a combination of the range of active movement together with the 'extent of total hand function' and the presence of postoperative oedema (Supplementary Table 4). He then proposed a postoperative assessment based on a four-part classification of the angle between the nail and the line of the metacarpals, with a further comment in the degree of flexion and complications (Davis, 1965).

Honner et al. (1971) described their results as 'excellent/good/fair/poor'. They based this on the degree of flexion and extension of the digits, level of function, and presence of recurrence and the extent to which the recurrence interfered with normal activity (Supplementary Table 5). Although they acknowledge that this system has 'serious limitations', they believe that as many others also use a similar 'excellent/good/fair/poor' system, it enabled them to compare their results with other published series. Unfortunately some of these 'comparative studies' use entirely different criteria in their selection of 'excellent, good, fair and poor' (Luck, 1959; McFarlane and Jamieson, 1966; Tubiana et al., 1968). Furthermore, Honner et al. explain that one of the limitations of their classification system is that many hands with PIP joint contractures before operation can never be better

**Table 1.** A review of articles published on Dupuytren's Disease in the *Journal of Hand Surgery* (British and European), *Journal of Hand Surgery* (American), *Journal of Bone and Joint Surgery* (British), *Journal of Bone and Joint Surgery* (American) and *Plastic and Reconstructive* over the past 15 years and the outcome measures used.

Author	Outcome measure used
White JW et al., 2012	Degree of contracture, functional questionnaire
Kemler MA et al., 2012	Functional limitations
Larocerie-Salgado et al., 2012	Degree of active extension at PIP joint
Lam WL et al., 2010	Histology and collagen levels
Donaldson OW et al., 2010	Degree of contracture
Balageur T et al., 2009	Histology, recurrence, extension of disease, presence of diathesis
Ullah AS et al., 2009	Range of movement, recurrence
Smith RP et al., 2009	Visual estimate compared with goniometer
Figus A et al., 2008	1st web angle, pictorial diagram of cord patterns
Hindocha S et al., 2006	Degree of contracture, risk factors (diathesis)
Van Rijssen AL et al., 2006	Contracture, DASH, patient satisfaction, Semmes-Weinstein monofilament sensory testing
Dias JJ and Braybrooke J, 2006	Degree of contracture, recurrence, PEM (patient evaluation measure)
Reilly et al., 2005	Degree of loss of extension. Location of disease, diathesis
Bulstrode NW et al., 2005	Joint angles, intraoperative findings, post op complications
Citron ND and Nunez V, 2005	Degree of contracture, recurrence, disease extension
Ritchie JF et al., 2004	Change in degree of fixed flexion
Bulstrode et al., 2004	Change in degree of PIPJ contracture
Beyermann K et al., 2004	Change in total active ROM
Citron N and Hearnden A, 2003	Recurrence, change in degree of MCP fixed flexion
Foucher G et al., 2003	Reoperation, change in degree of fixed flexion, percentage improvement
Sinha R et al., 2002	Degree of flexion deformity, Sollerman score
Clibbon JJ and Logan AM, 2001	Extension, recurrence
Armstrong JR et al., 2000	Recurrence
Badalamente MA and Hurst LC, 2000	Change in degree of fixed flexion
Roush TF and Stern PJ, 2000	Change in total active ROM, patient satisfaction
Citron N and Messina JC, 1998	Total fixed flexion deficit, PIPJ contracture, active ROM
Gonzalez MH et al., 1998	Change in degree of PIP/MCPJ contracture
Hall PN et al., 1997	Recurrence, recovery of active PIPJ flexion
Beard J and Trail I, 1996	Change in degree of contracture, active arc of motion
Breed CM and Smith PJ, 1996	Change in degree of PIPJ contracture
Moermans JP, 1996	Exxtension, recurrence, Tubiana score, Swanson impairment grade
Shaw DL et al., 1996	Change in total ROM
Ekerot L, 1995	Change in degrees of joint contracture

MCP: metacarpophalangeal; MCPJ: metacarpophalangeal joint; PIP: proximal interphalangeal; PIPJ: proximal interphalangeal joint; ROM: range of motion.

than fair, however good the response to surgery, whereas those with early contracture at the metacarpophalangeal (MCP) joint nearly always do well. The authors note also that, using this system, it is not possible to distinguish loss of flexion from loss of extension. While loss of flexion is rarely a problem prior to surgery, it could occur following surgery and is important to note (Honner et al., 1971).

Makela et al. (1991) (Supplementary Table 6) based their assessment on the excellent/good/fair/poor described by Honner et al., but also included a further measurement on the sum of the vertical distance by which the tip of the finger falls short of the

plane of full extension and the gap between the tip of the flexed finger and the distal palmar crease as described by Boyes (1950) in his method of evaluation of flexor tendon surgery. Unfortunately the method of correlating these two different assessments was not made clear by the authors (Makela et al., 1991).

It was perhaps the realization of such disparities when attempting to compare the results of so many different studies that prompted Early (1962) as far back as 1962 to write that 'there is a need for further surveys on a scale large enough to allow statistical analysis, using methods sufficiently standardized to enable comparisons to be made with the findings of

**Table 2.** Summary table of articles reviewed, classified by different scoring methods.

	1. Severity according to degree of contracture	2. Detailed scoring of individual digits	3. Condition severity or surgical results excellent/good/fair/poor or 0–4	4. Prediction of surgical difficulty	5. Questionnaire based or functional assessment scores
Meyerding, 1936	X		X (0–4)		
Einarsson, 1958	X		X (0–4)		
McIndoe and Beare, 1958	X		X (1–4)	X (See addendum to Supplementary Table 3)	X (Hand function mentioned)
Davis, 1965	X		X (Good/fair/poor/bad)		X (Hand 'use' mentioned)
Honner, 1971	X (Full/slight etc. no angles used) (See Supplementary Table 5)		X (Excellent/good/fair/poor)		X (Hand function/movement noted)
Makela et al., 1991	X (Tip-palm distance)		X (Good/fair/poor/failure)		
Early, 1962	X	X	X (0–IV)		
Tubiana et al., 2000	X	X	X (See Supplementary Table 8 for detail)		
Hindocha et al., 2008	X	X	X (Modification of Tubiana with additional criteria)		
Woodruff et al., 1998	X		X (1–5 with additional prefixes (see Table 9))	X	
Abe et al., 2004b	X		1–4	X	
Figus, 2008	X				
White, 2012	X		X (Excellent/good/fair/poor)		X
Kemler, 2012	X				X
DASH, PEM, Sollerman					X
BSSH	X		X (Mild/moderate/severe)		X

BSSH: British Society for Surgery of the Hand; PEM: patient evaluation measure.

other workers'. He proposed a scoring system in which points are allocated according to the degree of contracture of each individual digit. The points are then added together to provide a 'stage' 0–4 (Supplementary Table 7). Although this attempts to score the severity of disease affecting each digit and then add these points together depending also on how many digits are involved, there is some uncertainty as the author fails to specify whether the MCP joint should be included along with the proximal interphalangeal (PIP) and distal interphalangeal (DIP) joints when measuring the degree of contracture, although the reader might assume that all three joints should be assessed.

Tubiana et al. (1968) described one of the most comprehensive systems for scoring Dupuytren's disease. They aimed to provide an inclusive assessment covering a variety of different factors. They first published a proposal for a detailed classification of Dupuytren's disease in the English literature in 1961. The scheme was revised several times prior to the publication of the final version of their classification. This classification by Tubiana et al. grades the contracture into one of four stages based on the combined angles of contracture of the MCP and PIP joints. Although the original description discussed a calculation termed the coefficient of improvement, this did not appear in the final article (Tubiana et al., 1968).

The revised version of this classification (Tubiana et al., 2000) divides the hand into five segments, and for each finger gives a total flexion deformity score as shown in Supplementary Table 8. In the thumb ray, the scheme assesses the first web contracture based on the angle between the first and second metacarpals. A further score is given for the total flexion contracture in the thumb. Lesions are further characterized according to their location; in the palm (P) or digit (D). A PIP contracture of greater than 70° is denoted as D+. Fixed hyperextension of the DIP joint is denoted as H. Additional letters used are shown in table 8. A total score is then calculated with points awarded for each of the features described according to a scale.

Although Tubiana's method provides a comprehensive description of the hand, it is lengthy and could be regarded as too complicated for routine clinical use. Furthermore, as Tubiana explained, a hand with minor involvement of multiple digits may score more than a hand with a single severely affected digit. Nevertheless, it is frequently quoted in studies on Dupuytren's disease, particularly in Europe.

Hindocha et al. (2006) have attempted to refine Tubiana's system further. They produced a combined method of assessment of disease severity using Tubiana's original method of measuring degrees of digital contracture with other risk factors, such as the presence of diathesis. These authors believed that their 'Revised Tubiana staging system' could provide a more objective, accurate and precise method of clinical assessment and might provide an additional benefit in predicting surgical outcome. It has not yet been validated for use in clinical practice degree of contracture together with a note of the and some might argue that it makes an already complex assessment method even more complicated for use in a busy clinic.

Hoet used Tubiana's system to divide their patients into four groups; perfect, good, fair or failure (Hoet et al., 1988). Woodruff and Waldram (1998) proposed a pre-operative scoring system to attempt to predict the anticipated surgical difficulty of surgery in Dupuytren's disease. Their system was based on the presence of predisposing factors, risk of recurrence, degree of contracture together with a note of the sympathetic tone in the affected digits. The authors then use a letter as a prefix to describe additional or predisposing features in each patient (Supplementary Table 9).

Abe et al. (2004b) evaluated the surgical outcome following surgery for Dupuytren's disease in Japanese patients and proposed a pre-operative classification of Dupuytren's disease to facilitate the planning of treatment and help to predict the surgical outcome. They divided the flexion contractures caused by

Dupuytren's disease into four grades (1–4) depending on whether there was involvement of the MCP joint, involvement of the PIP joint and degree of loss of extension (Supplementary Table 10). The status of the hand was then expressed by the grade of the worst affected finger. They found no correlation between the pre-operative MCP joint contracture and the extent of improvement of the contracture postoperatively. There was, however, a statistically significant negative correlation between the extent of contracture improvement postoperatively and the pre-operative extension loss at the PIP joint. They concluded that according to their classification, those patients with Grade 3 and Grade 4 disease (who therefore had severe PIP joint contracture) required more than simply subtotal fasciectomy alone.

Additional procedures in these patients included checkrein ligament release, palmar capsulectomy, or even skeletal traction, arthrodesis or amputation. On this basis they suggested classifying the disease severity according to the worst affected PIP joint with a simple four-grade scale. They commented that their recurrence rate was lower than those quoted in studies on Caucasian populations and therefore cautioned the reader that they could not be certain whether their findings could be extrapolated from a Japanese to a European population.

Abe studied the factors associated in their practice with recurrence and extension of Dupuytren's disease (Abe et al., 2004a). They reviewed the notes of 65 patients and devised the following scoring system (which was also published in 2004 in the *J Hand Surg*):  $D = a + b + c + d + e + f$ , in which  $D$  is the diathesis score and  $a$  is the bilateral hand involvement (with = 1, without = 0),  $b$  the little finger surgery (with = 1, without = 0),  $c$  the early onset of disease (with = 1, without = 0),  $d$  the plantar fibrosis (with = 2, without = 0),  $e$  the knuckle pads (with = 2, without = 0) and  $f$  the radial side involvement (with = 2, without = 0). When  $D$  was greater than 4, there was a high risk of recurrence and extension, whereas there was little risk of recurrence and extension when  $D$  was less than 4.

Figus et al. (2008) presented a simple pictorial system which, combined with a measurement of the first web space angle, provided a method of recording the severity and progression over time of Dupuytren's disease affecting the thumb. Larocerie-Salgado and Davidson (2012) studied non-operative treatment. They measured simply the 'degree of active PIP extension of involved fingers' measured by goniometry. White et al. (2012) studied the effect of using a fixator in the pre-operative treatment of Dupuytren's. They selected their patients from a group with Tubiana Stage III/IV disease. They studied the results by measuring the residual flexion deformity of the

PIP joint. They devised a score of: an excellent outcome if this was  $<20^\circ$ , good if  $21\text{--}40^\circ$ , fair if  $41\text{--}60^\circ$  and poor if the residual contracture was  $>60^\circ$ . In addition, they describe a functional questionnaire in which they asked the following questions. Do you have any difficulty with the following: (1) putting your hand through your sleeve; (2) putting your hand in your pocket; (3) washing your face; (4) turning a round door handle; and (5) handling money. Only one patient had difficulty with any of these, suggesting that treatment was very successful or that the questionnaire may not be as useful as hoped for (Supplementary Table 11). Kemler et al. (2012) devised a seven-point scale to assess the results of postoperative splinting following Dupuytren's surgery (Supplementary Table 12). They measured the extension deficit of the PIP joint using goniometry and viewed this as the primary outcome measure. They did not score this. They also asked 'How would you rate the change in limitations caused by Dupuytren's disease since the start of treatment?' on a seven-point scale, indicating: 1 = worst ever; 2 = much worse; 3 = worse; 4 = not improved/not worse; 5 = improved; 6 = much improved; and 7 = immense improvement.

Functional and questionnaire assessments including the DASH, PEM and Sollerman tests have been used in various articles (Skoff, 2004). These assessments are not specific to Dupuytren's disease. Nevertheless Becker and Davis (2010) recommended that DASH and PEM should be used in any future studies on Dupuytren's disease.

The British Society for Surgery of the Hand (BSSH), in their Evidence for Surgical Treatment for Dupuytren's disease document, describe a classification of mild, moderate and severe adapted from Dias and Braybrook (Dias et al., 2006). Their system is based on: hand function, extent of MCP contracture, extent of PIP contracture and presence of first web contracture (Supplementary Table 13). The BSSH uses this 'classification system' as a tool to determine the recommendations for treatment. Dupuytren's disease has also been classified on a histological basis. Luck (1959) divided the disease into three stages: proliferative, involutinal and residual. Others have studied the number of mitoses (Tyrkko and Viljanto, 1975), and the association between myofibroblasts and recurrence of the disease (Gelberman et al., 1980). (Rombouts et al. (1989) proposed a three-stage histological classification of Dupuytren's disease and identified a relationship between the histological type using this classification and the rate of recurrence. Rombouts et al. also found that there was no correlation between the histological type and the risk of disease extension.

Balaguer et al. (2009) agreed that histological staging is a reliable method for predicting recurrence. However, he found no correlation between the histological type and the presence of features of diathesis and therefore concluded that histological staging is an independent risk factor for recurrence in Dupuytren's disease. Balaguer recommended that although histological type can help predict postoperative recurrence, it should be used in association with clinical data to determine more precisely the prognosis of patients with Dupuytren's contracture. Lam et al. (2010) modified Luck's classification by quantifying the variation in the amount of Type III and Type I collagen in each of Luck's three stages. They reported a decrease in the amount of Type III collagen as a percentage of the total collagen with disease progression from Stage I to Stage III. In the light of these findings, they proposed a new staging system based on the relative amount of Type III collagen: stage 1:  $>35\%$ ; stage 2:  $<35\%$  and  $>20\%$ ; and stage 3:  $<20\%$ .

Table 1 illustrates the various methods of assessment of Dupuytren's Disease that different authors have used over the past century.

## Discussion

The number and variety of different classification systems that have been described for the assessment of Dupuytren's disease over the past century is indicative of the fact that there is no perfect system for assessing this condition. Unfortunately the variety of different systems used in the published literature makes the comparison of patients in different centres, the use of different techniques and even the natural history of the condition difficult to assess. It is clear that the major inconsistencies in reporting Dupuytren's disease in the literature are due, in part, to the lack of a universally recognized assessment and the classification system is undesirable. Becker and Davis' (2010) recommendations attempt to address this.

The system described by Tubiana (Tubiana et al., 2000, 1968) and further expanded by Hindocha et al. (2006) is perhaps the most comprehensive of the systems that have been developed. Its main disadvantage is that it is cumbersome and is, some would argue, too time consuming to carry out making it unlikely to find universal or even widespread clinical acceptance. Woodruff and Waldram's (1998) system is simple, but aims simply to predict surgical time rather than specifically record the complexity of the disease. Histological systems such as that of Luck (1959) are of limited value to clinicians, particularly as they do not enable us to advise the patient pre-operatively.



Ultimately, if a scoring system is going to be effective it needs to be simple, widely understood and widely accepted. Perhaps the inherent complexity of this common condition, the variation in clinical expression between individuals and the fact that it is still not yet fully understood, means that any scoring system will inevitably be a compromise. Table 2 shows a summary of the various categories that different authors have incorporated into their scoring systems. Nevertheless hand surgeons should embrace this challenge so that meaningful comparative studies can be performed in the future.

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