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DOYLE INDEX IS A VALUABLE ADDITIONAL PAIN MEASURE IN OSTEOARTHRITIS

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ABSTRACT

Objective. To determine reliability, feasibility and validity of the Doyle Index (DI), a pain score proposed for osteoarthritis (OA).

Methods. The DI was performed in 260 patients with OA at multiple sites (mean age 64.9 years, 84% women) by grading pain (0-3) in 48 joints and joint groups by palpation or passive movement. Reliability and feasibility were determined in a random sample of 18 patients, by examining them twice using four raters. Intraclass correlation coefficients (ICCs) for intra- and interrater reliability were calculated, as well as the mean time to perform the DI. Validity was assessed in 260 patients, by correlating DI total scores and DI scores for the hand and knee/hip joints separately, to the pain and function subscales of the Australian/Canadian Osteoarthritis Hand Index (AUSCAN) and Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), using Spearman's rank coefficient (r).

Results. In the total population the median (interquartile range) DI score was 11.0 (5.0-19.0). Intrarater ICCs (95%CI) ranged from 0.94 (0.84 to 0.98) to 0.97 (0.93 to 0.99). Interrater ICC was 0.88 (0.77 to 0.94). The mean time to perform the total DI was 5.1 minutes (range 2.4-7.8). DI total scores as well as scores for the hand and knee/hip joints separately were related to AUSCAN (r range 0.61-0.65) and WOMAC (r range 0.43-0.51), although the level of correlation was moderate.

Conclusion. The DI is a reliable, easy to perform and valid measure for OA pain during physical examination and therefore a promising additional outcome measure not only for OA research but also for clinical practice.

INTRODUCTION

Osteoarthritis (OA) is a common heterogeneous joint disorder which may affect any joint, but mostly the hand joints, knees, hips and spine. Often multiple joints are affected in a patient. Joint pain is the primary symptom of OA, accompanied by stiffness and gradual loss of function. To date only treatment of symptoms is available.

Pain is one of the core outcome measures in the evaluation of OA.[1,2] It can be assessed using subscales of standardised questionnaires or a single item global pain Visual Analog Scale, both reflecting self-reported pain.[2] In addition, pain can be assessed during physical examination, which may reflect a different aspect of disease. Self-reported pain may incorporate more psychosocial aspects, whereas pain on physical examination may be less subjective.

A standardised method to assess pain during physical examination is lacking. In 1981 an articular index for the assessment of joint pain in OA was proposed, the Doyle Index (DI).[3] This articular index is a modification of the Ritchie index which is widely used in rheumatoid arthritis.[4] The DI includes 48 joints or joint groups for assessment, based on the pattern of joint involvement in OA. Since it may evaluate other aspects of pain than questionnaires, it can be a valuable additional outcome measure in OA. However, its clinimetric properties have not been investigated yet.

Therefore we determined the reliability, feasibility and validity of the DI in patients with OA at multiple sites. Besides its application in research, the DI can be used in patient care.

METHODS

Study design and patient population

The study population consisted of 260 patients participating in the Genetics ARthrosis and Progression (GARP) study, visiting for a follow-up evaluation after 6 years.[5] Patients were included in the GARP study with familial OA at multiple sites in the hands or in at least two joint sites being hand, knee, hip or spine. They were required to have symptomatic OA in at least one joint site. In case of one symptomatic OA joint site, structural abnormalities in at least one other joint site were required. Symptomatic hand OA was defined according to the American College of Rheumatology (ACR) criteria.[6]. In the knee, hip and spine symptomatic OA was defined as a combination of symptoms and radiographic OA signs as described by the ACR criteria.[7,8] Details on the recruitment and follow-up have been published elsewhere.[5,9] The study was approved by the medical ethics committee.

A random sample of 18 patients was used to determine reliability and feasibility during an additional visit. Using four raters the DI was performed twice in each patient by each rater, with a 90-minute time interval. The order in which patients were assessed differed between raters and between the first and second scoring. The time to perform the DI in each patient was measured using a stopwatch. All raters were familiar with the DI and consensus on how to conduct the DI was reached in advance.

Doyle Index

Using the DI, pain is graded during physical examination in 48 joints or joint groups (table 1) by pressure on the lateral joint margin or by passive joint movement on a four-point scale: 0=no pain, 1=patient complains of pain, 2=patient complains of pain and winces, 3=patient complains of pain, winces, and withdraws joint. The total score ranges from 0 to 144. Joints with prosthesis are not graded and not included in the score.

Subscores for the hand were calculated by summing the scores for all hand joints (range 0 to 72). The same was done for the knee and hip (range 0 to 12).

Questionnaires

Self-reported pain and functional limitations were assessed with the corresponding subscales of the Australian/Canadian Osteoarthritis Hand Index (AUSCAN) and Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), assessing hand and knee and hip, respectively.[10,11] Using the AUSCAN, pain and functional limitations are graded on a Likert scale (0=none to 4=extreme), total scores ranging from 0 to 20 and 0 to 36, respectively. WOMAC scores range from 0 to 100 since the VAS format was used.

Table 1. Using the Doyle Index pain is graded 0-3 in 48 joints or joint groups by palpation or passive movement.

Joint	Method of testing	Number of units
DIP 2-5 (individually)	Pressure	8
PIP 2-5, IP-1 (individually)	Pressure	10
MCP 2-5	Pressure	2
MCP-1	Pressure	2
CMC-1	Pressure	2
Wrist	Pressure	2
Elbow	Pressure	2
Shoulder	Pressure	2
Acromioclavicular	Pressure	1
Sternoclavicular	Pressure	1
Cervical spine	Movement	1
Lumbar spine	Movement	1
Hip	Movement	2
Knee	Pressure	2
Ankle	Movement	2
Talocalcaneal	Movement	2
Midtarsal	Movement	2
MTP-1	Pressure	2
MTP 2-5	Pressure	2
Total		48

Abbreviations: DIP: distal interphalangeal; PIP: proximal interphalangeal; IP-1: first interphalangeal; MCP: metacarpophalangeal; CMC-1: first carpometacarpal; MTP: metatarsal.

Statistical analysis

Data were analysed using SPSS 16.0 (SPSS, Chicago, Illinois, USA). To evaluate intra- and interrater reliability intraclass correlation coefficients (ICCs) with 95% confidence intervals (95%CI) were estimated using a one-way random ANOVA model and a two-way random ANOVA model for absolute agreement, respectively. Before estimating the final ICC it was assessed whether DI scores within one patient got worse as effect of repetitive assessment. In addition, the Bland and Altman method was used.[12]

Feasibility was determined by calculating the mean time to perform the DI for each rater separately and for all raters together. The relationship between the performance time (dependent variable) and DI scores (independent variable) was determined using linear regression analysis.

Construct validity was assessed by testing three *a priori* defined hypotheses. The first was that the DI is positively related to self-reported pain and function. This was tested by correlating DI scores to the pain and function subscales of the AUSCAN and WOMAC using Spearman's rank correlation coefficient, r, with 95%CI. Secondly, we determined whether DI hand and knee/hip scores correlated to pain and function measured with the AUSCAN and WOMAC, respectively. Finally, we tested whether DI scores increased with an increasing number of OA joint sites, using the Kruskal-Wallis test.

RESULTS

Population description

Patient characteristics are shown in table 2. The median (interquartile range (IQR)) DI total score was 11.0 (5.0-19.0). Median (IQR) DI scores for the hand and the knee/hip joints separately were 4.0 (2.0-9.0) and 2.0 (0.0-3.0), respectively.

Table 2. Patient characteristics of 260 patients with osteoarthritis (OA) at multiple sites.

Age, mean (SD) years	64.9 (7.2)
Women, no (%)	217 (84)
Body mass index, mean (SD) kg/m^2	28.3 (5.7)
Symptomatic OA sites, no (%)	
Hand OA	206 (81)
Knee OA	98 (39)
Hip OA	80 (32)
Spine OA	193 (75)
AUSCAN pain (0-20), mean (SD)	7.2 (4.8)
AUSCAN function (0-36), mean (SD)	13.7 (8.8)
WOMAC pain (0-100), mean (SD)	28.6 (25.8)
WOMAC function (0-100), mean (SD)	28.2 (24.0)

Abbreviations: AUSCAN: Australian/Canadian Osteoarthritis Hand Index, WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index.

Reliability

Intrarater reliability for the four raters separately was high (table 3). The average intrarater ICC (95%CI) was 0.95 (0.93 to 0.97). The ICC (95%CI) for interrater reliability was 0.88 (0.77 to 0.94). No effect of repetitive assessment was present, meaning that DI scores per patient did not increase with a second performance.

Bland-Altman plots for intrarater reliability did not show any systematic differences (not shown). However, from plots for interrater reliability (figure 1) it seems that there are some systematic differences between raters.

Feasibility

The mean time to perform the DI for the four raters is shown in table 3. For all raters together the mean time was 5.1 minutes (range 2.4-7.8 minutes). The time to perform the DI was positively related to the DI total score, meaning that it took more time to perform the DI in patients with more pain.

Construct validity

DI total scores and scores for the hand and the knee/hip joints separately were related to the pain and function subscales of the AUSCAN and WOMAC (table 4). However, the level of correlation was only moderate. With an increasing number of OA joint sites DI scores increased. Median (IQR) DI scores for patients with one, two, three and four symptomatic OA sites were 7.0 (3.5-13.5), 10.0 (5.0-16.0), 16.0 (9.0-25.0), and 16.0 (7.0-24.0), respectively ($p<0.01$).

Table 3. Intrarater reliability for each rater and overall interrater reliability expressed as intraclass correlation coefficients (ICC) and time to perform the Doyle Index for four raters in 18 patients with osteoarthritis at multiple sites.

	Intrarater reliability ICC (95%CI)	Interrater reliability ICC (95%CI)	Time, minutes mean (SD)
Rater 1	0.97 (0.93 to 0.99)	0.88 (0.77 to 0.94)	4.3 (0.8)
Rater 2	0.95 (0.88 to 0.98)		5.8 (1.4)
Rater 3	0.94 (0.84 to 0.98)		6.0 (0.7)
Rater 4	0.95 (0.86 to 0.98)		4.1 (0.3)

Table 4. Correlation of the Doyle Index (DI) with AUSCAN and WOMAC expressed as Spearman's rank correlation coefficient (95%CI) in 260 patients with osteoarthritis at multiple sites.

	DI total	DI hand	DI knee/hip
AUSCAN pain	0.61 (0.53 to 0.68)	0.65 (0.57 to 0.72)	-
AUSCAN function	0.62 (0.54 to 0.69)	0.61 (0.53 to 0.68)	-
WOMAC pain	0.51 (0.42 to 0.59)	-	0.46 (0.36 to 0.55)
WOMAC function	0.49 (0.39 to 0.58)	-	0.43 (0.33 to 0.52)

For all values $p<0.01$
Abbreviations: see table 2.

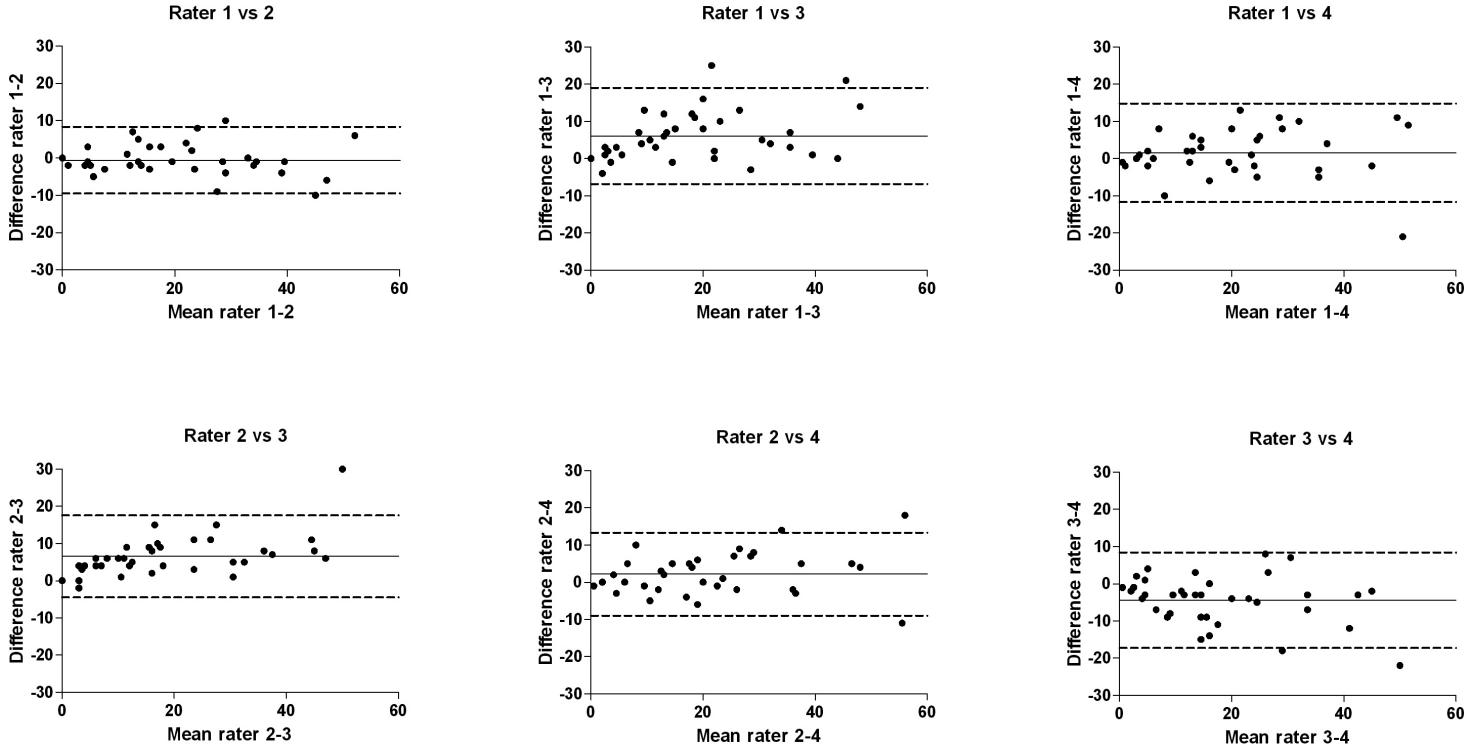

Figure 1. Bland-Altman plots showing the differences in Doyle Index scores between raters in relation to the mean Doyle Index score. The solid line represents the mean difference between two raters, the dotted line represents the limits of agreement.

Sensitivity analysis in patients without prosthesis (n=203) showed similar correlations between WOMAC and DI scores. DI scores for the whole lower extremity showed the same level of correlation to WOMAC as DI total scores.

DISCUSSION

This study in patients with OA at multiple sites showed that the DI is a reliable, feasible and valid measure for pain in OA. Intra- and interrater reliability were high and on average it took 5 minutes to perform the DI. The higher the DI score, the more time it takes to perform. Patients with more symptomatic joint sites involved had higher DI scores. The DI is obtained during physical examination and therefore may reflect a different aspect of disease than self-reported pain, which is supported by the modest strength of correlation between the DI and self-reported outcome measures. The favorable clinimetric properties in combination with the possibility to assess all joints together as well as specific joint groups separately, make the DI a valuable additional outcome measure for OA research and use in clinical practice.

The Outcome Measures in Rheumatology (OMERACT) filter identifies three concepts that should be evaluated for a potential outcome measure: truth (validity), feasibility and discrimination (reliability and sensitivity to change).[13] In this study sensitivity to change was not assessed. However, follow-up data over 2 years from the GARP study on a modified DI and self-reported pain measured with the AUSCAN and WOMAC have been published.[14,15] Using the modified DI the same joints were assessed, only grading was slightly different. The studies showed that the sensitivity to change of the modified DI concerning the hand joints and the knee/hip joints, expressed by the standardised response mean (SRM), was 0.67 and 0.41, respectively. The sensitivity to change of the AUSCAN and WOMAC pain subscale was lower with SRMs of 0.25 and 0.15, respectively. Because the modified DI is very similar to the DI, we feel that the sensitivity to change of the DI will be comparable, being better than established outcome measures for pain in OA.

The DI is hand-oriented since half of the assessed joints belong to the hand. We have shown that the DI subscores for separate joint groups have comparable correlations with self-reported outcome as the DI total score. The reliability for the subscores was good, but ICCs were slightly lower because of the lower possible range in DI subscores compared to the DI total score. This implies that the DI can be used to assess separate joint groups, which is valuable for clinical trials.

Besides its use for research purposes, the DI can be used in clinical practice, especially the subscores for specific joint groups. We have shown that it takes approximately 5 minutes to perform the total DI. Performing only part of the DI takes less time and therefore implementation in daily clinical practice seems realistic. Because of its good clinimetric properties it can be a valuable measure since it is more quantitative in nature than taking a pain history only.

We found a moderate level of correlation between AUSCAN and WOMAC and the DI. This supports the idea that self-reported outcomes measure other aspects of disease than physician obtained outcomes. Our findings are in line with two studies

assessing the validity of the AUSCAN and WOMAC showing comparable or lower levels of correlation with a modified DI.[10,16] In inflammatory arthritis similar levels of correlation between self-reported and clinically obtained outcome measures have been reported.[17,18]

There are some limitations to the present study. First, the study was conducted in patients with familial OA at multiple sites. The behaviour of the DI in other OA phenotypes may be different, although pain is a shared symptom in all OA manifestations. Second, the mean level of self-reported symptoms in this population seems to be low considering the Patient Acceptable Symptom State (PASS).[19] Assuming that self-reported symptoms are related to pain on physical examination, this will result in relatively low DI scores. We expect the influence on study outcome to be minimal since ICCs and correlation coefficients are more dependent on the variability in measures.[20] We feel that the variability in AUSCAN, WOMAC as well as DI scores in this study population was sufficient. Moreover, a higher mean level of symptoms does not imply more variability in scores. Finally, it was not possible to assess responsiveness to treatment, since this is an observational study. Responsiveness is an important issue when use in clinical trials is concerned. In the original DI paper this feature was evaluated in a double-blind cross-over study.[3] It was demonstrated that compared to treatment with a simple analgesic, treatment with an anti-inflammatory agent resulted in a significant reduction of the DI score. No effect on self-reported pain was observed, supporting that the DI has better features than self-reported outcomes.

In conclusion, this study demonstrated that the DI is a reliable, easy to perform and valid measure of pain in OA. Its sensitivity to change, evaluated previously in the GARP study, was higher than established OA pain outcome measures. Because of these favorable clinimetric properties and the idea that pain during physical examination may reflect a different aspect of the disease, the DI seems a valuable additional outcome measure not only for OA research but also for clinical practice.

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