Rating systems for evaluation of the elbow

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Introduction: Many scoring systems have been used for elbow disorders. However, only few of these have been validated, and many assess only few aspects of elbow function.

Methods: A literature search was performed using the keyword 'elbow' in combination with 'scoring system', 'outcome assessment', 'elbow disorder' and 'clinical evaluation'.

Results: Eighteen scoring systems are currently available for the evaluation of elbow disorders. Each of them evaluates the elbow performance using specific variables, including both objective and subjective criteria. All these scoring systems are presented.

Discussion: Although many scoring systems have been used to evaluate elbow function, we are still far from a single outcome evaluation system which is reliable, valid and sensitive to clinically relevant changes, takes into account both patients' and physicians' perspective and is short and practical to use.

Conclusion: Further studies are required to evaluate the reliability, validity and sensitivity of the elbow scoring systems used in the common clinical practice.

Introduction

The measurement of patients' outcomes in modern orthopaedic practice includes the use of scoring systems to determine general health, regional, joint- and disease-specific results.[1] Two types of questionnaires are available: physician-rated and patient-rated questionnaires. Physician-rated questionnaires use clinical and functional measurements. On the other hand, patient-rated questionnaires assess subjective component of a condition.[2,3] Questionnaires must be properly validated in terms of consistency, sensitivity and reliability.[4]

The development of instruments to measure the outcome of management of musculoskeletal disorders of elbow has been the subject of increasing interest. Many scoring systems have been used for elbow disorders.[5] However, only few of these have been validated, and many assess only some aspects of elbow function.[4]

Each score assesses elbow performance by specific criteria which are different among various scales.[6] Their domains are often unrelated, with little uniformity in the distribution of categories, and different weights to the various aspects of elbow performance.[7] Bias can be present both in objective criteria (derived from physical examination) and subjective criteria (determined by interview). This makes the interpretation of results and the valid comparison between studies very difficult.[8]

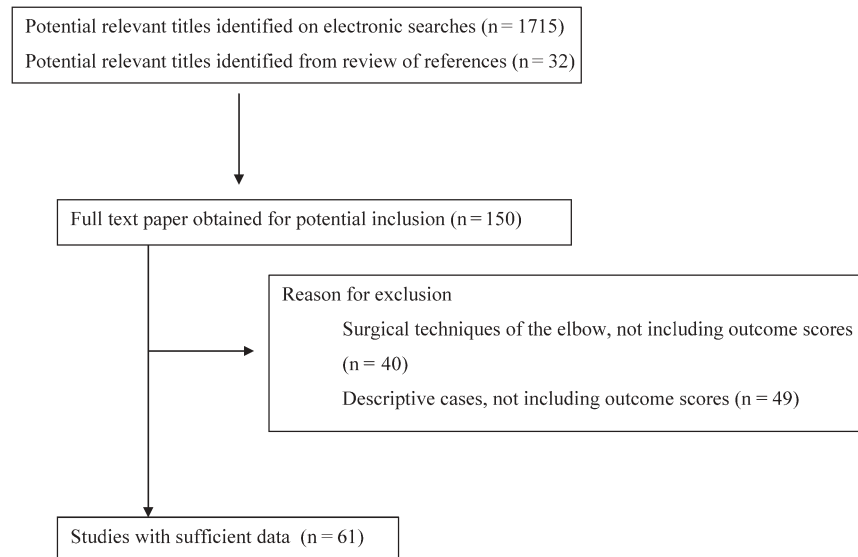In this paper, we review the more common elbow score systems and their use in current orthopaedic practice.

Methods

We performed a search using the keyword 'elbow' in combination with 'scoring system', 'outcome assessment', 'elbow disorder' and 'clinical evaluation', with no limit regarding the year of publication. The following databases were accessed on 15th April 2008: PubMed (http://www.ncbi.nlm.nih.gov/sites/entrez/); Ovid (http://www.ovid.com); Cochrane Reviews (http://www.cochrane.org/reviews/). Given the linguistic capabilities of the research team, we considered the publications in English, Spanish and Italian. Two authors (U.G.L. and M.L.) independently read the abstract of each publication identified (if an abstract was available). If no abstract was available, the publication was excluded. In addition, the References section of all the publications identified were studied to ascertain whether other relevant material could be found. The personal collection of scientific material of the three senior authors (F.F., N.M. and V.D.) was consulted for the same purpose. If deemed relevant, all relevant publications were retrieved. The most relevant material was drawn between the years 1990 and 2007. A large number of publications focusing on surgical techniques of the elbow, not including outcome scores, were not included. The publications thus selected were examined by all authors. After this further selection, 61 publications relevant to the topic at hand were included (Fig. 1).

Analytical description of elbow scoring systems

American Shoulder and Elbow Surgeons-Elbow
The American Shoulder and Elbow Surgeons-Elbow (ASES-E) is a standardized elbow evaluation developed by the Research Committee of

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┌─────────────────────────────────────────────────────────────────┐
│ Potential relevant titles identified on electronic searches       │
│ (n = 1715)                                                        │
│                                                                   │
│ Potential relevant titles identified from review of references    │
│ (n = 32)                                                          │
└─────────────────────────────────────────────────────────────────┘
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         ┌──────────────────────────────────────────────┐
         │ Full text paper obtained for potential        │
         │ inclusion (n = 150)                           │
         └──────────────────────────────────────────────┘
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                              │        ┌──────────────────────────────────────────────────────┐
                              ├───────▶│ Reason for exclusion                                 │
                              │        │    Surgical techniques of the elbow, not including   │
                              │        │    outcome scores (n = 40)                           │
                              │        │    Descriptive cases, not including outcome scores   │
                              │        │    (n = 49)                                          │
                              │        └──────────────────────────────────────────────────────┘
                              ▼
         ┌──────────────────────────────────────────────┐
         │ Studies with sufficient data  (n = 61)        │
         └──────────────────────────────────────────────┘
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Fig. 1 Details of the investigations excluded and included in the study.

the American Shoulder and Elbow Surgeons[1] (ASES) (Table 1). This score allows the evaluation of elbow function independently from the underlying diagnosis. It consists of two parts: a patient questionnaire and a form for the physician to record elbow impairment.

The patient self-evaluation form is divided into three sections: pain, function and satisfaction. The first section contains visual analogical scales (from 0 = no pain to 10 = worst pain ever) for pain evaluation. The second section contains questions relating to the function of right and left arms. The responses are scored on a four-point ordinal scale: 0 = unable to do; 1 = very difficult to do; 2 = somewhat difficult; 3 = no difficult. The third section assesses the success of surgery on a scale from 0 to 10.

The section on physician assessment consists of four parts: motion, stability, strength and physical findings. Regarding motion, the physician records active flexion, extension, pronation and supination for both elbows. Active range of motion is measured with a standard goniometer. Concerning stability, the involved elbow is evaluated for valgus, varus and posterolateral rotatory instability. Each of them is graded on a four-point scale: 0 = no instability; 1 = mild laxity with good endpoint; 2 = moderate laxity with no endpoint; 3 = gross instability. Strength is rated in flexion, in extension, in pronation and in supination with a six-point scale: 0 = no contraction; 1 = flicker; 2 = movement with gravity eliminated; 3 = movement against gravity; 4 = movement with some resistance; 5 = normal power. Grip strength is also recorded. A series of possible physical findings are listed so that the examiner can

Table 1 ASES-E scoring system.

PATIENT SELF-EVALUATION: PAIN										

Do you experience pain in your elbow?									Yes	No
Rate your pain: 1) When it is at its worst	1	2	3	4	5	6	7	8	9	10
2) At rest	1	2	3	4	5	6	7	8	9	10
3) Lifting a heavy object	1	2	3	4	5	6	7	8	9	10
4) When doing a task with repeated elbow movements	1	2	3	4	5	6	7	8	9	10
5) At night	1	2	3	4	5	6	7	8	9	10

0 = no pain; 10 = worst pain ever

PATIENT SELF-EVALUATION: FUNCTION		

Circle the number that indicates your ability to do the following activities
0 = unable to do; 1 = very difficult to do; 2 = somewhat difficult; 3 = not difficult

ACTIVITY	RIGHT ARM	LEFT ARM
Do up top of button on shirt	0 1 2 3	0 1 2 3
Manage toiletting	0 1 2 3	0 1 2 3
Comb hair	0 1 2 3	0 1 2 3
Tie shoes	0 1 2 3	0 1 2 3
Eat with utensil	0 1 2 3	0 1 2 3
Carry a heavy object	0 1 2 3	0 1 2 3
Rise from chair pushing with arm	0 1 2 3	0 1 2 3
Do heavy household chores	0 1 2 3	0 1 2 3
Turn a key	0 1 2 3	0 1 2 3
Throw a ball	0 1 2 3	0 1 2 3
Do usual work (describe)	0 1 2 3	0 1 2 3
Do usual sport (describe)	0 1 2 3	0 1 2 3

PATIENT SELF-EVALUATION: SATISFACTION

Are you satisfied with your elbow surgery
        1   2   3   4   5   6   7   8   9   10
not at all satisfied   very satisfied

PHYSICIAN ASSESSMENT: MOTION		
ACTIVE RANGE OF MOTION (degrees)	RIGHT	LEFT
Flexion		
Extension		
Flexion/Extension arc		
Pronation		
Supination		

Pronation/Supination arc		
PHYSICIAN ASSESSMENT: STABILITY		

0 = no instability; 1 = mild laxity with good endpoint; 2 = moderate laxity no endpoint; 3 = gross instability

INSTABILITY	RIGHT	LEFT
Valgus	0 1 2 3	0 1 2 3
Varus	0 1 2 3	0 1 2 3
Posterolateral rotatory	0 1 2 3	0 1 2 3

Continued

Table1 *Continued*

PHYSICIAN ASSESSMENT: STRENGTH				
0 = no contraction; 1 = flicker; 2 = movement with gravity eliminated; 3 = movement against gravity; 4 = movement with some resistance; 5 = normal power				
		RIGHT		LEFT
Testing affected by pain?		Y/N		Y/N
Flexion		0 1 2 3 4 5		0 1 2 3 4 5
Extension		0 1 2 3 4 5		0 1 2 3 4 5
Pronation		0 1 2 3 4 5		0 1 2 3 4 5
Supination		0 1 2 3 4 5		0 1 2 3 4 5
Grip strength (Kg)				

PHYSICIAN ASSESSMENT: SIGNS				
0 = none; 1 = mild; 2 = moderate; 3 = severe				
SIGN		RIGHT		LEFT
Ulnohumeral tenderness		0 1 2 3		0 1 2 3
Radiocapitellar tenderness		0 1 2 3		0 1 2 3
Medial flexor origin tenderness		0 1 2 3		0 1 2 3
Lateral extensor origin tenderness		0 1 2 3		0 1 2 3
Medial collateral ligament tenderness		0 1 2 3		0 1 2 3
Posterior interosseous nerve tenderness		0 1 2 3		0 1 2 3
Other tenderness – specify:		Y/N		Y/N
Impingement pain in flexion		0 1 2 3		0 1 2 3
Impingement pain in extension		0 1 2 3		0 1 2 3
Pain on resisted wrist extension		Y/N		Y/N
Pain on resisted wrist flexion		Y/N		Y/N
Pain on resisted long finger extension		Y/N		Y/N
Pain on resisted wrist pronation		Y/N		Y/N
Pain on resisted wrist supination		Y/N		Y/N
Ulnohumeral crepitus		Y/N		Y/N
Radiocapitellar crepitus		Y/N		Y/N
Scars (location)		Y/N		Y/N
Atrophy (location)		Y/N		Y/N
Deformity (describe)		Y/N		Y/N
Ulnar nerve tinels		Y/N		Y/N
Cubital tunnel stretch test		Y/N		Y/N
Other joints limiting activity: shoulder/wrist		Y/N		Y/N
Other physical findings				

record abnormalities. The physical findings enclose the evaluation of tenderness, graded on a four-point scale (0 = none; 1 = mild; 2 = moderate; 3 = severe), and other signs (such as pain, scars and atrophy) are reported described only as present or absent (Y/N).

Disability of Arm, Shoulder and Hand Questionnaire

The Disability of Arm, Shoulder and Hand (DASH) Questionnaire[9] (Table 2) is a standardized questionnaire which evaluates impairments and activity limitations, as well as participation restrictions for both

Table 2 DASH questionnaire.

DISABILITY/SYMPTOMS SECTION					
1 = no difficulty; 2 = mild difficulty; 3 = moderate difficulty; 4 = severe difficulty; 5 = unable					
1. Open a tight or new jar	1	2	3	4	5
2. Write	1	2	3	4	5
3. Turn a key	1	2	3	4	5
4. Prepare a meal	1	2	3	4	5
5. Push open a heavy door	1	2	3	4	5
6. Place an object on a shelf above your head	1	2	3	4	5
7. Do heavy household chores (e.g. wash walls, wash floors)	1	2	3	4	5
8. Garden or yard work	1	2	3	4	5
9. Make a bed	1	2	3	4	5
10. Carry a shopping bag or briefcase	1	2	3	4	5
11. Carry a heavy object (over 10 lbs)	1	2	3	4	5
12. Change a light-bulb overhead	1	2	3	4	5
13. Wash or blow dry your hair	1	2	3	4	5
14. Wash your back	1	2	3	4	5
15. Put on a pullover sweater	1	2	3	4	5
16. Use a knife to cut food	1	2	3	4	5
17. Recreational activities which require little effort (e.g. card playing, knitting etc.)	1	2	3	4	5
18. Recreational activities in which you take some force or impact through your arm, shoulder or hand (e.g. golf, hammering, tennis etc.)	1	2	3	4	5
19. Recreational activities in which you move your arm freely (e.g. playing Frisbee, badminton etc.)	1	2	3	4	5
20. Manage transportation needs	1	2	3	4	5
21. Sexual activities	1	2	3	4	5
22. During the past week, to what extent has your arm, shoulder or hand interfered with your normal social activities with family, friends, neighbours or groups?	1	2	3	4	5
23. During the past week, were you limited in your work or other daily activities as a result of your arm, shoulder or hand problem?	1	2	3	4	5
24. Arm, shoulder or hand pain	1	2	3	4	5
25. Arm, shoulder or hand pain when you perform any specific activity	1	2	3	4	5
26. Tingling (pins and needles) in your arm, shoulder or hand	1	2	3	4	5
27. Weakness in your arm, shoulder or hand	1	2	3	4	5
28. Stiffness in your arm, shoulder or hand	1	2	3	4	5
29. During the past week, how much difficulty have you had sleeping because of the pain in your arm, shoulder or hand?	1	2	3	4	5
30. I feel less capable, less confident or less useful because of my arm, shoulder or hand problem	1	2	3	4	5

OPTIONAL SECTION					
SPORTS/MUSIC					
1. Using your usual technique for playing your instrument or sport?	1	2	3	4	5
2. Playing your usual musical instrument or sport because of arm, shoulder, or hand pain?	1	2	3	4	5
3. Playing your usual musical instrument or sport as well as you would like?	1	2	3	4	5
4. Spending your usual amount of time practicing or playing your instrument or sport?	1	2	3	4	5
WORK					
1. Using your usual technique for your work?	1	2	3	4	5
2. Doing your usual work because of arm, shoulder, or hand pain?	1	2	3	4	5
3. Doing your work as well as you would like?	1	2	3	4	5
4. Spending your usual amount of time doing your work	1	2	3	4	5

leisure activities and work.[10] The DASH consists of three sections: the first module includes questions about symptoms and disabilities of upper limb (30 items); the second and the third sections are optional. The optional modules produce scores for participation with regard to sports/music (four items) and work activities (four items). All items of DASH are scored with a five-point scale: 1 = no difficulty; 2 = mild difficulty; 3 = moderate difficulty; 4 = severe difficulty; 5 = unable. For each module, the sum of the responses produces a score, which then is transformed to obtain the DASH scores. This score ranges between 0 (no disability) and 100 (severe disability) for each domain. Therefore, a high DASH score indicates severe disability.

Quick*DASH*

The *Quick*DASH[11] (Table 3) is a shortened version of the DASH scoring system. It consists of 11 items to measure physical function and symptoms in people with any or multiple musculoskeletal disorders of the upper limb. Similar to the DASH, each item has five response options (1 = no difficulty; 2 = mild difficulty; 3 = moderate difficulty; 4 = severe difficulty; 5 = unable). From the item scores, a summative score is calculated. The final score ranges between 0 (no disability) and 100 (the greatest possible disability). Only one missing item can be tolerated, and, if two or more items are missing, the score cannot be calculated.[12]

Musculoskeletal function assessment

The musculoskeletal function assessment (MFA) instrument[13] comprises 100 items grouped into 10 categories: self-care; sleep/rest; hand/

Table 3 *Quick*DASH.

QUICKDASH ITEMS					
1 = no difficulty; 2 = mild difficulty; 3 = moderate difficulty; 4 = severe difficulty; 5 = unable					
1) Open jar	1	2	3	4	5
2) Pain intensity	1	2	3	4	5
3) Tingling intensity	1	2	3	4	5
4) Sleep	1	2	3	4	5
5) Socialize	1	2	3	4	5
6) Wash back	1	2	3	4	5
7) Forceful recreation	1	2	3	4	5
8) Heavy chores	1	2	3	4	5
9) Carry a bag	1	2	3	4	5
10) Use knife	1	2	3	4	5
11) Limited in work	1	2	3	4	5

fine motor skills; mobility; housework; employment/work; leisure/recreational activities; family relationships; cognition/thinking; emotional adjustment, coping and adaptation (Table 4). Earlier versions of the questionnaire[13] used in its developmental phase included 100 items, because there was one item less in the employment/work category. All categories and total score have been calculated and standardized on a scale of 0–100. Patients assess their function by answering 'yes' or 'no' to each item; each 'yes' response corresponds to 1 point, and each 'no' response or unanswered question corresponds to 0 points. The total score can range from 0 to 100 points, with 0 representing minimum dysfunction and 100 representing maximum dysfunction. It takes ∼15 min to complete. Validity analyses require supplemental questions about sociodemographic characteristics such as race, education, income, marital status, health insurance, work status, co-morbid conditions, health habits and changes in life and health status.[14]

The MFA instrument shows good content validity and reliability.[13] Its scoring scheme, with the highest scores assigned to the patients with the most disability, matches those used by other functional status instruments.[15] A study has compared the MFA with three health status measures [Medical Outcomes Study Short Form-36 (SF-36), the WOMAC and the SIP] used to evaluate musculoskeletal disorders. The

Table 4 Musculoskeletal function assessment.

Categories	No. of items	Examples
Self-care	18	Do you wear things that are easier to get into? Is it difficult to brush your teeth?
Sleep/rest	6	Are you tired all the time? Is it hard for you to get comfortable to sleep?
Hand/fine motor skills	7	Do you have trouble holding a book? Do you have difficulty writing or typing?
Mobility	20	Do you feel unsteady on your feet? Is it difficult for you to reach up high?
Housework	9	Does it take you longer to do household chores? Do you need help with housework or yardwork?
Employment/work	4	Are you making changes in your job? Do you take more breaks?
Leisure/recreation	4	Is your physical fitness worse because of your injury/illness?
Family relationships	10	Do you do less of your usual physical recreational activities'?
Cognition/thinking	4	Do you feel you just don't want to be around anybody? Do you feel like being less intimate?
Emotional adjustment/coping/ adaptation	18	Are you more forgetful? Do you have problems with concentration? Do you feel disabled, even though you look fine to others? Do you feel your life has changed quite a bit?

MFA must perform as good as or better than other questionnaires according to the criteria of reliability, validity and responsiveness.[14]

Short musculoskeletal functional assessment

The short musculoskeletal functional assessment[16] (SMFA) is a short-form MFA (Table 5). It is a self-reported 46-item questionnaire consisting of two parts: a dysfunction index and a bother index. The dysfunction index consists of four categories (daily activities, emotional status, function of the arm and hand, mobility) and has 34 items: 25 items evaluate the amount of difficulty that patients have when performing certain functions; and nine items evaluate how often the patients have difficulty when performing certain functions. Each item is graded with a five-point scale ranging from 'good function' to 'poor function'. The bother consists of 12 items and assesses how much the patient is bothered by problems associated with broad functional areas. The bother index is also graded with a five-point scale, ranging from 1 point (not at all bothered) to 5 points (extremely bothered). The scores are calculated by summing the responses to the items and then transforming the scores so that they range from 0 to 100. This transformation is made with use of the formula: [(actual raw score − lowest possible raw score)/possible range of raw score] × 100. The total score ranges from 0 to 100, with higher scores indicating a poorer level of function.[17]

Patient-rated elbow evaluation

The patient-rated elbow evaluation[18] (PREE) consists of two sections investigating pain and function (Table 6). All questions are scored on a 10-point scale. The pain section has four questions that rate pain from 'no pain' to 'worst ever'. In addition, there is a question that rates how often the patient has pain ('never' to 'always'). The scale for the function questions ranges from 'no difficulty' to 'unable to do'. The function section has 11 questions regarding specific activities of daily living, and four questions regarding personal care, household work, occupational work and recreational activities. Higher scores represent worse functioning.[17,19]

Liverpool elbow score

The Liverpool elbow score[4] (LES) is an elbow-specific score. It consists of two main components (Table 7): a patient-rated questionnaire which assesses the elbow function, including a question about pain; and

Table 5 Short musculoskeletal function assessment.

QUESTIONS					
1=not at all difficult, 2=a little difficult, 3=moderately difficult, 4=very difficult, 5=unable to do					
1. How difficult is it for you to get in or out of a low chair?	1	2	3	4	5
2. How difficult is it for you to open medicine bottles or jars?	1	2	3	4	5
3. How difficult is it for you to shop for groceries or other things?	1	2	3	4	5
4. How difficult is it for you to climb stairs?	1	2	3	4	5
5. How difficult is it for you to make a tight first?	1	2	3	4	5
6. How difficult is it for you to get in or out of the bathtub or shower?	1	2	3	4	5
7. How difficult is it for you to get comfortable to sleep?	1	2	3	4	5
8. How difficult is it for you to bend or kneel down?	1	2	3	4	5
9. How difficult is it for you to use buttons, snaps, hooks or zippers?	1	2	3	4	5
10. How difficult is it for you to cut your own fingernails?	1	2	3	4	5
11. How difficult is it for you to dress your self?	1	2	3	4	5
12. How difficult is it for you to walk?	1	2	3	4	5
13. How difficult is it for you to get moving after you have been sitting or lying down?	1	2	3	4	5
14. How difficult is it for you to go out by yourself?	1	2	3	4	5
15. How difficult is it for you to drive?	1	2	3	4	5
16. How difficult is it for you to clean yourself after going to the bathroom?	1	2	3	4	5
17. How difficult is it for you to turn knobs or levers (for example. to open doors or to roll down car windows)?	1	2	3	4	5
18. How difficult is it for you to write or type?	1	2	3	4	5
19. How difficult is it for you to pivot?	1	2	3	4	5
20. How difficult is it for you to do your usual physical recreational activities, such as bicycling, jogging or walking?	1	2	3	4	5
21. How difficult is it for you to do your usual leisure activities, such as hobbies, crafts, gardening, card-playing or going out with friends?	1	2	3	4	5
22. How much difficulty are you having with sexual activity?	1	2	3	4	5
23. How difficult is it for you to do light housework or yard work, such as dusting, washing dishes or watering plants?	1	2	3	4	5
24. How difficult is it for you to do heavy housework or yard work, such as washing floors, vacuuming or mowing lawns?	1	2	3	4	5
25. How difficult is it for you to do your usual work, such as a paid job, housework or volunteer activities?	1	2	3	4	5
These next questions ask how often you are experiencing problems <u>this week</u> because of your injury or arthritis. 1=none of the time, 2=a little of the time, 3=some of the time, 4=most of the time, 5=all of the time					
26. How often do you walk with a limp?	1	2	3	4	5
27. How often do you avoid using your painful limb(s) or back?	1	2	3	4	5
28. How often does your leg lock or give-way?	1	2	3	4	5
29. How often do you have problems with concentration?	1	2	3	4	5
30. How often does doing too much in one day affect what you do the next day?	1	2	3	4	5
31. How often do you act irritable toward those around you (for example. snap at people, give sharp answers or criticize easily)?	1	2	3	4	5
32. How often are you tired?	1	2	3	4	5
33. How often do you feel disabled?	1	2	3	4	5
34. How often do you feel angry or frustrated that you have this injury or arthritis?	1	2	3	4	5
These questions are about how much you are bothered by problems you are having <u>this week</u> because of your injury or arthritis. 1=not at all bothered, 2=a little bothered, 3=moderately bothered, 4=very bothered, 5=extremely bothered					

Continued

Table 5 *Continued*

35. How much are you bothered by problems using your hands, arms or leg?	1 2 3 4 5
36. How much are you bothered by problems using your back?	1 2 3 4 5
37. How much are you bothered by problems doing work around your home?	1 2 3 4 5
38. How much are you bothered by problems in bathing, dressing, toiletting or other personal care?	1 2 3 4 5
39. How much are you bothered by problems with sleep and rest?	1 2 3 4 5
40. How much are you bothered by problems with leisure or recreational activities?	1 2 3 4 5
41. How much are you bothered by problems with your friends, family or other important people in your life?	1 2 3 4 5
42. How much are you bothered by problems with thinking, concentrating or remembering?	1 2 3 4 5
43. How much are you bothered by problems adjusting or coping with your injury or arthritis?	1 2 3 4 5
44. How much are you bothered by problems doing your usual work?	1 2 3 4 5
45. How much are you bothered by problems with feeling dependent on others?	1 2 3 4 5
46. How much are you bothered by problems with stiffness and pain?	1 2 3 4 5

clinical data, which can be measured objectively, regarding the condition of the elbow. The patient-answered questionnaire contains nine items. Each of them is graded using a five-point scale, from 0 (worst/least function) to 4 (best/most function). Clinical assessment score component contains six items, and some of them are graded using a four-point scale (from 0 to 3), whereas others are graded using a three-point scale (from 0 to 2). For calculation of the final score, all responses are transformed to a scale of 0–10. Therefore, the final score ranges between 10 (best) and 0 (worst).

Mayo elbow performance index

The Mayo elbow performance index[20] (MEPI) is one of the most commonly used physician-based elbow rating systems. This index consists of four parts (Table 8): pain (with a maximum score of 45 points), ulnohumeral motion (20 points), stability (10 points) and the ability to perform five functional tasks (25 points). Pain is rated as none (45 points); mild (30 points) if there is no limitation of activity and occasional use of analgesics; moderate (15 points) if there is limitation of activity and regular use of analgesics; severe (0 points) if there is constant pain and regular use of analgesics. The joint's stability is graded as stable, mildly unstable or unstable. The functional score is determined on the basis of the patient's ability to perform normal activities of daily living. The total score ranges from 5 to 100 points, with higher scores indicating better function. If the total score is included between 90 and 100 points, it can be considered excellent;

Table 6 Patient-rated elbow evaluation.

1. PAIN	
*Rate the average amount of pain in your elbow **over the past week** by circling the number that best describes your pain on a scale from 0-10. A **zero (0)** means that you **did not have any pain** and a **ten (10)** means that you had **the worst pain you have ever experienced. Rate your pain:***	
When it is at its worst	0 1 2 3 4 5 6 7 8 9 10
At rest	0 1 2 3 4 5 6 7 8 9 10
When lifting a heavy object	0 1 2 3 4 5 6 7 8 9 10
When doing a task with repeated elbow movement	0 1 2 3 4 5 6 7 8 9 10
How often do you have pain?	0 1 2 3 4 5 6 7 8 9 10 Never Always

2. FUNCTION	
A. SPECIFIC ACTIVITIES	
*Rate the **amount of difficulty** you experienced performing each of the items listed below, over the past week, by circling the number that best describes your difficulty on a scale of 0-10. A **zero (0)** means you did not experience any difficulty and a **ten (10)** means it was so difficult you were unable to do it at all.*	
	0 = No Difficulty 10 = Unable To Do
Comb my hair	0 1 2 3 4 5 6 7 8 9 10
Eat with a fork or spoon	0 1 2 3 4 5 6 7 8 9 10
Pull a heavy object	0 1 2 3 4 5 6 7 8 9 10
Use my arm to rise from a chair	0 1 2 3 4 5 6 7 8 9 10
Carry a 10 lb object with my arm at my side	0 1 2 3 4 5 6 7 8 9 10
Throw a small object, such as a tennis ball	0 1 2 3 4 5 6 7 8 9 10
Use a telephone	0 1 2 3 4 5 6 7 8 9 10
Do up buttons on the front of my shirt	0 1 2 3 4 5 6 7 8 9 10
Wash my opposite armpit	0 1 2 3 4 5 6 7 8 9 10
Tie my shoe	0 1 2 3 4 5 6 7 8 9 10
Turn the doorknob and open a door	0 1 2 3 4 5 6 7 8 9 10
B. USUAL ACTIVITIES	
*Rate the **amount of difficulty** you experienced performing your **usual** activities in each of the areas listed below, over the past week, by circling the number that best describes your difficulty on a scale of 0-10. By "usual activities", we mean the activities that you performed **before** you started having a problem with your elbow. A **zero (0)** means you did not experience any difficulty and a **ten (10)** means it was so difficulty you were unable to do any of your usual activities.*	
Personal activities (dressing, washing)	0 1 2 3 4 5 6 7 8 9 10
Household work (cleaning, maintenance)	0 1 2 3 4 5 6 7 8 9 10
Work (your job or everyday work)	0 1 2 3 4 5 6 7 8 9 10
Recreational activities	0 1 2 3 4 5 6 7 8 9 10

between 75 and 89 points, good; between 60 and 74 points, fair; less than 60 points, poor.[21–24]

Variants of MEPI

The first variant of the modified version of the Mayo elbow score[25] was used for a comparison of pre-operative and post-operative status, in a study which evaluated the Kudo elbow prosthesis in patients with

Table 7 Liverpool elbow score.

	Score 4	Score 3	Score 2	Score 1	Score 0
Clinical assessment					
1. Flexion	-	>135°	120–135°	90–120°	<90°
2. Extension	-	None	<20°	20–30°	>30°
3. Pronation (add 1 to score if wrist/forearm pathology)	-	-	>50°	50–20°	<20°
4. Supination (add 1 to score if wrist/forearm pathology)	-	-	>50°	50–20°	<20°
5. Strength: average of flexion, extension, pronation and supination	Apparently normal	Complete motion against gravity and some resistance	Complete motion against gravity	Complete motion with gravity eliminated	Absent
6. Ulnar nerve	-	None	Sensory	Motor: no disability	Motor: with disability
Patient-answered questions					
During the past four weeks:					
1. How often have you had to use your other arm to do things normally done by the affected arm?	Never	Once or twice	Sometime	Many times	Every time
2. Has your elbow problem caused you any difficulty in combing your hair?	None	Little	Moderate	Severe	Unable to do
3. Has your elbow problem caused you any difficulty in washing yourself?	None	Little	Moderate	Severe	Unable to do
4. Has your elbow problem caused you any difficulty in feeding yourself?	None	Little	Moderate	Severe	Unable to do
5. Has your elbow problem caused you any difficulty in dressing yourself?	None	Little	Moderate	Severe	Unable to do
6. Has your elbow problem caused you any difficulty in trying to do household activities?	None	Little	Moderate	Severe	Unable to do
7. Has your elbow problem caused you any difficulty in lifting, e.g. a kettle, a milk bottle, groceries?	None	Little	Moderate	Severe	Unable to do
8. How would you describe the pain from this elbow?	None	Little	Moderate	Severe	Unbearable
9. Has your elbow problem affected your sport and leisure activities?	None	Little	Moderate	Severe	Unable to do

rheumatoid arthritis.[26] In this score (Table 9), total active range of motion, instability and pain are recorded. Patient satisfaction and pain are determined on a four-point scale. Results are classified according to total score, which ranges between 0 and 100. If the total score ranges

Table 8 Mayo elbow performance index.

Variable	Definition	No. of points
PAIN (max., 45 points)	None	45
	Mild	30
	Moderate	15
	Severe	0
RANGE OF MOTION (max., 20 points)	Arc >100 degrees	20
	Arc 50 to 100 degrees	15
	Arc <50 degrees	5
STABILITY (max., 10 points)	Stable	10
	Moderately unstable	5
	Grossly unstable	0
FUNCTION (max., 25 points)	Able to comb hair	5
	Able to feed oneself	5
	Able to perform personal hygiene tasks	5
	Able to on shirt	5
	Able to put on shoes	5

between 75 and 100, the result is good (satisfactory); 50–74, fair, acceptable; <50, poor (or unsatisfactory).

The second variant of the modified version of the Mayo elbow score[27] is a performance index which is based on pain and joint's function as follows: motion, 40 points; pain, 35 points; strength, 20 points; stability, 5 points. Pain is rated as none, mild or severe. Motion is recorded with goniometric measurements of flexion, extension, pronation and supination. Strength is evaluated with biomechanical assessments with a torque dynameter; the loss of strength can involve only flexion or extension or pronation or supination, but is also possible that there is a composite strength loss. Regarding stability, clinical examination assesses varus/valgus instability. This instability is graded as follows: none; mild, if a perception of instability is observed by the physician; moderate, if definite instability is observed; severe, if perceptible varus/valgus laxity is detected by the physician and perceived by the patient. A total score which is comprised between 95 and 100 points is considered excellent; 80–95, good; 60–80, fair; <60, poor.

The third variant of the modified version of the Mayo elbow score[28] is an objective elbow performance index based on elbow's function and pain. It is a 100-point system and includes several domains: motion, 40 points; pain, 35 points; strength, 20 points; stability, 5 points. Pain is graded as none, mild, moderate or severe. The varus/valgus instability is evaluated according to a previously described

Table 9 Variant of MEPI.

Criteria	No. of points
PAIN (max., 60 points)	
None	60
Mild to occasional, no medication	40
Moderate to occasional, activity limited, medication	20
Severe to incapacitating	0
MOTION (max. 30 points)	
Arc of extension/flexion:	
>90	30
60–89	20
30–59	10
<30	0
STABILITY (max., 10 points)	
Effect on function of the elbow	
None or mild (does not limit activity)	10
Moderate (impairs certain functions)	5
Severe (markedly limits activity)	0

technique,[29] and it is scored as none, mild, moderate and severe. Motion is measured with a hand-held goniometer. The strength of flexion and extension is assessed according to a clinical rating scale, which assigns 20 points for normal strength; 14 points for mild loss of strength; 7 points for moderate loss of strength; 0 points for marked weakness. The results of elbow performance index can range between 0 and 100 and are rated as follows: an excellent result ranges from 91 to 100 points; good, 81 to 90 points; fair, 71 to 80 points; poor, ≤70 points.

Broberg and Morrey rating system

The rating system of Broberg and Morrey (Table 10) is a 100-point system, which summarizes data from the clinical record, personal interview and biomechanics laboratory examination.[29] It consists of four sections: motion (40 points), strength (20 points), stability (5 points) and pain (35 points). Pain is rated as none (35 points); mild with activity but requiring no medication (28 points); moderate with or after activity (15 points); severe at rest, requiring constant medication, and disabling (0 points). The clinical and biomechanical assessments are obtained measuring motion with a hand goniometer and assessing flexion/extension of the elbow and pronation/supination of the

Table 10 Broberg and Morrey rating system.

Variable	No. of points
Motion (total for each plane) (degrees)	
Flexion (0.2 × arc)	27
Pronation (0.1 × arc)	6
Supination (0.1 × arc)	7
Strength	
Normal	20
Mild loss (appreciable but not limiting; strength 80% that of contralateral side)	13
Moderate loss (limits some activity; strength 50% that of contralateral side)	5
Severe loss (limits everyday tasks, disabling)	0
Stability	
Normal	5
Mild loss (perceived by patient, no limitation)	4
Moderate loss (limits some activity)	2
Severe loss (limits everyday tasks)	0
Pain	
None	35
Mild (with activity, no medication)	28
Moderate (with or after activity)	15
Severe (at rest, constant medication, disabling)	0

forearm. The grip strength of the hand is measured with a specially designed torque dynamometer. Stability is graded by varus–valgus stress according to the technique described previously.[30]

In the categorical rating, 95–100 points indicates an excellent outcome; 80–94 points, a good outcome; 60–79 points, a fair outcome; ≤60 points, a poor outcome.[21] The outcome can be considered satisfactory if the result is rated as good or excellent, and unsatisfactory if it is fair or poor.

The Hospital for Special Surgery scoring system

The Hospital for Special Surgery (HSS) scoring system[31] consists of eight domains (Table 11): pain, function, sagittal range, muscle strength, flexion contracture, extension contracture, pronation and supination. Pain is evaluated in bending and at rest; its maximum score is 30, which reflects a condition of no pain at any time. In the function's evaluation, ability to perform bending activities and ability to perform a task are considered: patient score 8 points when able to perform bending activities for 30 min, and 0 points when they cannot

Table 11 The HSS scoring system.

	Points
I. Pain (30 points)	
1. No pain at any time	30
2. No pain when bending	15
3. Mild pain when bending	10
4. Moderate pain when bending	5
5. Severe pain when bending	0
6. No pain at rest	15
7. Mild pain at rest	10
8. Moderate pain at rest	5
9. Severe pain at rest	0
II. Function (20 points)	
A. 1. Bending activities for 30 mins.	8
2. Bending activities for 15 mins.	6
3. Bending activities for 5 mins.	4
4. Cannot use elbow	0
B. 1. Unlimited use of elbow	12
2. Limited only for recreation	10
3. Household and employment	8
4. Independent self-care	6
5. Invalid	0
III. Sagittal range (20 points)	
One point for each 7 degrees of motion	
IV. Muscle strength (10 points)	
1. Can lift 5 lbs. (2.3 kg) to 90 degrees	10
2. Can lift 2 lbs. (0.9 kg) to 90 degrees	8
3. Moves through range of motion against gravity	5
4. Cannot move through range of motion	0
V. Flexion contracture (6 points)	
1. Less than 15 degrees	6
2. Between 15 and 45 degrees	4
3. Between 45 and 90 degrees	2
4. More than 90 degrees	0
VI. Extension contracture (6 points)	
1. Within 15 degrees of 135 degrees	6
2. Less than 125 degrees	4
3. Less than 100 degrees	2
4. Less than 80 degrees	0
VII. Pronation (4 points)	
1. More than 90 degrees	4
2. More than 30 to 60 degrees	3
3. More than 15 to 30 degrees	2
4. Less than 0 degrees	0
VIII. Supination (4 points)	
1. More than 60 degrees	4
2. More than 45 to 60 degrees	3
3. More than 15 to 45 degrees	2
4. Less than 0 degrees	0

use elbow. Regarding ablity to perform a task, patients score 12 points when there is an unlimited use of elbow, and 0 points when they are invalid. The maximum score for function is 20 (12 + 8). In the

evaluation of the sagittal range, patients receive 1 point for each 7° of motion, to a maximum score of 20. Flexion and extension contractures have both a maximum score of 6. Pronation and supination have both a maximum score of 4. An excellent result is considered to be a score of 90–100 points; a good result, 80–89 points; a fair result, 70–79 points; a poor result, 60–69 points; a failed result, <60 points.[32]

Variants of the HSS scoring system

A shortened version of the HSS Scoring System[33] consists of four domains (Table 12): pain, function, activity and use. Pain ranges between not pain (50 points) and severe pain (0 points). Function ranges between no limitations (30 points) and unable to feed oneself (0 points). Activity ranges between capacity to perform activities for 30 min (8 points) and inability to use the elbow (0 points). Use ranged between unlimited use (12 points) and invalid (0 points). Activity

Table 12 Variant of the HSS scoring system.

Variable	No. of points
Pain	
None or ignored	50
Slight; occasionally uses analgesics	45
Moderate; uses analgesics daily	35
Moderate at rest or at night	15
Severe; disabled	0
Function	
No limitations	30
Slight limitations; no restrictions in activities of daily living	25
Unable to lift objects >4.5 Kg	20
Moderate restrictions in activities of daily living	10
Unable to comb hair or touch head	5
Unable to feed self	0
Activity	
Can perform activities for:	
30 mins.	8
15 mins.	6
5 mins.	4
Cannot use elbow	0
Unlimited use	12
Limited use for recreation	10
Limited to household and employment activities	8
Able to care for self	6
Invalid	0

The scores for activity (max 8 points) and use (max 12 points) are added together to produce a total activity score (max 20 points)

domain and use domain can be added to produce a total activity score, which has a maximum of 20 points. As the function domain includes a total activity score, the HSS Scoring System gives the same weight to pain and function, because each of these domains has a 50-points score. Regarding outcome, a total score of 90–100 points indicates an excellent result; 80–89 points, a good result; 70–79 points, a fair result; <60 points, a failure.[24]

Ewald scoring system

Ewald scoring system is a 100-point rating system,[34] which evaluates several aspects of elbow function (Table 13). Its domains are pain, 50 points; function, 30 points; motion, 10 points; flexion contracture, 5 points; cubitus valgus alignment, 5 points. The functional evaluation is limited to the involved elbow and includes six categories: no limitations, slight restriction of activities of daily living, unable to lift

Table 13 Ewald scoring system.

Variable	
Pain	
None	50
Slight	45
Moderate	35
Interferes with sleep at night	15
Severe	0
Function	
No limitations	30
Slight restrictions	25
Unable to lift heavy objects (>4.5 Kg)	20
Moderate restrictions in activities of daily living	10
Unable to comb hair or touch head	5
Unable to feed self	0
Motion (degrees)	
Flexion >130°	10
Extension 110°–130°	5
Supination 90°–110°	2
Pronation <90°	0
Deformity	
Permanent flexion contracture <5°	5
Permanent flexion contracture 15°–30°	2
Permanent flexion contracture >30°	0
Valgus 0°–10°	5
Decubitus varus 0°–5°	2
Decubitus varus >5°	0

objects weighing more than 10 pounds (4.5 kg), moderate restriction of activities of daily living, unable to comb the hair or touch the head and unable to feed oneself. Pain evaluation includes five categories: none, slight, moderate, interferes with sleep at night, severe. Regarding motion, the physician measures degrees of flexion, extension, pronation and supination.[35,36] Rating categories were grouped as follows: excellent, 90–100; good, 80–89; fair, 70–79; poor, ≤69 points.[37]

Khalfayan score

Khalfayan scoring system[38] investigates: pain, elbow range of motion, strength (including both elbow and grip strength) and daily activity (Table 14). Each category has a maximum score of 25 points. Patients are interviewed regarding pain and level of function in specific activities of daily living. Clinical examination consists of elbow range of motion, elbow strength and grip strength measured with a hand-held dynamometer.

Pain is rated as none (30 points), slight with continuous activity and no medication required (25 points), moderate with occasional activity and some medication required (15 points), moderately severe with much pain and frequent medication (10 points), severe with constant pain and markedly limited activity (5 points) and complete disability (0 points). The maximum points of pain are 30. The score is calculated by the formula: (points divided by 30) × 25. The maximum score is 25.

The evaluation of elbow's motion range consists in measuring degrees of extension (8 points maximum), flexion (17 points maximum), pronation (6 points maximum) and supination (6 points maximum). Degrees of extension are included between >70° (0 points) and <10° (8 points). Degrees of flexion are included between >120° (17 points) and <30° (0 points). Regarding pronation and supination, 0.1 points per each degree are assigned. The maximum points for range of motion are 37 (8 + 17 + 6 + 6). The score is calculated by the formula: (points divided by 37) × 25. The maximum obtainable score is 25.

Strength measurement includes both elbow and grip strength. Elbow strength (10 points maximum) is rated as normal, good, fair, poor, trace and paralysis. Strength in extension, flexion, pronation and supination is rated. To obtain elbow strength points, the sum of extension, flexion, pronation and supination indexes is computed. At the end, the total index is multiplied by 0.67. The evaluation of grip strength (8 points maximum) is expressed as a percentage of the uninjured extremity. The range is between ≥90% (8 points) and ≥50% (4 points). The maximum points for strength are 18 (10 + 8). The score is

Table 14 Khalfayan score.

1. Pain (maximum points = 30)		
None		30
Slight with continuous activity, no medication		25
Moderate, with occasional activity, some medication		15
Moderately severe, much pain, frequent medication		10
Severe, constant pain, markedly limited activity		5
Complete disability		0
Score = (points divided by 30) × 25		

2. Motion (maximum points = 37)					
	Extension (8 points maximum)				
	71° − 90°				0
	51° − 70°				2
	31° − 50°				5
	11° − 30°				7
	<10°				8
	Flexion (17 points maximum)				
	>120°				17
	111° −120°				15
	101° − 110°				13
	91° − 100°				11
	71° − 90°				9
	51° − 70°				6
	31° − 50°				3
	<30°				0
	Pronation/supination (6 points maximum each) 0.1 point per degree				
	Score = (points divided by 37) × 25				

3. Strength (maximum points = 18)					
	A. Elbow strength (10 points)				
		Flexion Index	Extension Index	Pronation Index	Supination Index
	Normal	5	4	3	3
	Good	4	3	2	2
	Fair	3	2	1	1
	Poor	2	1	0	0
	Trace	1	0	0	0
	Paralysis	0	0	0	0
Total Index (Flex. Ind. + Ext. Ind. + Pron. Ind. + Sup. Ind.) × 0.67 = elbow strength points					
B. Grip strength (8 points)					
Percentage of uninjured extremity:					
≥90%					8
≥80%					7
≥70%					6
≥60%					5
≥50%					4
Score = (points divided by 18) × 25					

4. Function (maximum points = 12)					
	Normal	Mild	Difficulty	With aid	Unable

Continued

Table 14 *Continued*

		compromise			
1) Use back pocket	1	0.75	0.5	0.25	0
2) Rise from chair	1	0.75	0.5	0.25	0
3) Perineal care	1	0.75	0.5	0.25	0
4) Wash opposite axilla	1	0.75	0.5	0.25	0
5) Eat with utensil	1	0.75	0.5	0.25	0
6) Comb hair	1	0.75	0.5	0.25	0
7) Carry 10-15 lb with arm at side	1	0.75	0.5	0.25	0
8) Dress	1	0.75	0.5	0.25	0
9) Pulling	1	0.75	0.5	0.25	0
10) Throwing	1	0.75	0.5	0.25	0
11) Do usual work	1	0.75	0.5	0.25	0
12) Do usual sport	1	0.75	0.5	0.25	0
Score = (points divided by 12) × 25					

5. Elbow score (sum of scores A + B + C + D)

90–100	Excellent
80–89	Good
70–79	Fair
<70	Poor

calculated by the formula: (points divided by 18) × 25. The maximum obtainable score is 25.

Elbow's function is rated as normal (1 point), mild compromise (0.75 points), difficulty (0.5 points), with aid (0.25) and unable (0 points). It is evaluated in 12 conditions: (i) use back pocket; (ii) rise from chair; (iii) perineal care; (iv) wash opposite axilla; (v) eat with utensil; (vi) comb hair; (vii) carry 10–15 lb with arm at side; (viii) dress; (ix) pulling; (x) throwing; (xi) do usual work and (xii) do usual sport. The maximum points for function are 12. The score is calculated by the formula: (points divided by 12) × 25. The maximum obtainable score is 25.

The final score is included between 0 and 100. A result between 90 and 100 is considered excellent; between 80 and 89, good; between 70 and 79, fair; poor if it is <70. An acceptable outcome is considered with excellent or good results (score 80–100), and an unacceptable outcome with fair or poor results (score <80).[39]

Flynn criteria

Flynn criteria[40,41] are obtained measuring with goniometers the range of elbow movement and the carrying angle (Table 15). Both loss in carrying

Table 15 Flynn criteria.

Outcome Loss	Loss in carrying angle (degrees)	Loss in elbow motion (degrees)
Excellent	0–5	0–5
Good	6–10	6–10
Fair	11–15	11–15
Poor	>15	>15

angle and loss in elbow motion are scored as follows: between 0 and 5°, excellent; 6–10°, good; 11–15°, fair; <15°, poor.

Neviaser criteria

These criteria have been arbitrarily established by the authors to study long-term follow-up of elbow dislocation.[42] The range of motion is scored as follows: excellent, when there is a $\leq 10°$ loss of full extension with full supination and pronation; good, when there is no greater than a 30° loss of extension and/or no more than a 10° loss of supination or pronation; fair, when there is no greater than a 45° loss of extension and/or no more than a 30° loss of either supination or pronation; poor, when there is a loss of more than a 45° loss of extension and/or more than a 30° loss of either supination or pronation.

Jupiter criteria

Jupiter criteria evaluate pain, disability and range of movement.[43] Symptoms are recorded at clinical interview, and the patients are examined clinically and radiographically.[44] Elbow and forearm movements are measured using a standard large goniometer, recording the extension of the elbow with the forearm in maximal supination. Double-exposure photographs show the range of elbow movement, and loss of flexion/extension is expressed by comparison with the normal arm. Ulnar nerve function is also assessed (Table 16).

Oxford elbow score

The Oxford elbow score is a 12-item questionnaire (Table 17).[45] It comprises three unidimensional domains: elbow function, pain and social-psychological, with each domain comprising four items with good measurement properties.

Table 16 Jupiter criteria.

	Range of movement (degrees)		Pain	Disability
	Loss of extension	Loss of flexion		
Excellent	<15	>130	None	None
Good	<30	>120	Slight	Minimal
Fair	<40	>90	With activity	Moderate
Poor	<40	>90	Variable	Severe

Discussion

Many elbow score rating systems have been described.[5] Each of them evaluates the elbow performance using specific variables, including both objective and subjective criteria. Also, when the same parameters are evaluated, a different weight is attributed to the single domain. Interpreting these domains becomes difficult, because, even though they can be common to more than one scoring system, each stresses them in a different way.[4,7]

There is a strong influence of pain on elbow ratings and health status measures.[46] However, the experience and expression of pain are strongly influenced by psychological and sociological factors.[47,48] As a result of the influence of pain on both physician-rated and patient-rated quantitative measures of elbow function, objective improvements in elbow function achieved by operative procedures may be undervalued by these systems. Therefore, subjective factors such as pain should probably be evaluated separately from objective measures of elbow function in physician-based elbow ratings.[21]

The ASES-E[1] is an organ-specific score which has been developed by the Research Committee of the ASES. This score consists of a patient self-evaluation, which allows the evaluation of pain and functional deficits, and a physician assessment section. This score contains objective criteria, represented by measurements of motion, stability and strength.

The PREE[18] is another organ-specific score in which both pain and function are investigated. The evaluation of elbow function is performed by questions, whereas in the ASES-E, objective evaluation is made by measurements.[17,19] The LES[4] also evaluates elbow function by measurements. It assesses elbow's function and pain by questions, and the condition of the elbow by objectively measured clinical data. Reproducibility and internal consistency are good. Both pre-operative results and the effects of surgery correlate acceptably with the DASH score.

Table 17 Oxford elbow score.

During the past 4 weeks..........	
1. Have you had difficulty lifting things in your home, such as putting out the rubbish, because of your elbow problem?	
	No difficulty
	A little bit of difficulty
	Moderate difficulty
	Extreme difficulty
	Impossible to do
2. Have you had difficulty carrying bags of shopping, because of your elbow problem?	
	No difficulty
	A little bit of difficulty
	Moderate difficulty
	Extreme difficulty
	Impossible to do
3. Have you had any difficulty washing yourself all over, because of your elbow problem?	
	No difficulty
	A little bit of difficulty
	Moderate difficulty
	Extreme difficulty
	Impossible to do
4. Have you had any difficulty dressing yourself, because of your elbow problem?	
	No difficulty
	A little bit of difficulty
	Moderate difficulty
	Extreme difficulty
	Impossible to do
5. Have you felt that your elbow problem is "controlling your life"?	
	No, not at all
	Occasionally
	Some days
	Most days
	Every day
6. How much has your elbow problem been "on your mind"?	
	Not at all
	A little of the time
	Some of the time
	Most of the time
	All of the time

Continued

Table 17 *Continued*

7. Have you been troubled by pain from your elbow in bed at night?	
	Not at all 1 or 2 nights
	Some nights Most nights Every night
8. How often has your elbow pain interfered with your sleeping?	No, not at all
	Occasionally
	Some days
	Most days
	All of the time
9. How much has your elbow problem interfered with your usual work or everyday activities?	
	Not at all
	A little bit
	Moderately
	Greatly
	Totally
10. Has your elbow problem limited your ability to take part in leisure activities that you enjoy doing?	
	No, not at all
	Occasionally
	Some days
	Most days
	All of the time
11. How would you describe the worst pain you had from your elbow?	
	No pain
	Mild pain
	Moderate pain
	Severe pain
	Unbearable
12. How would you describe the pain you usually had from your elbow?	
	No pain
	Mild pain
	Moderate pain
	Severe pain
	Unbearable

The DASH[9] is available in several languages, and studies of its test–re-test reliability and construct validity have been published for the original English version,[49–52] and for the Swedish,[53] German,[54] Spanish,[55] Dutch,[56] Italian,[57] Chinese[58] and Japanese[59] versions. One of the optional DASH modules, the work module, has been studied only in the Italian,[60] Chinese[58] and Japanese[59] versions. The DASH score has been used in patients with disorders of major areas of the extremity, such as shoulder, elbow, wrist and hand.[59] The construct validity of DASH score has been evaluated by establishing its correlation to SF-36,[51] which is used for measuring health outcomes in patients with musculoskeletal ailments. The DASH Questionnaire correlates moderately well to SF-36 and is a valid measure of health status in patients with a variety of upper extremity disorders.

The DASH score is strongly correlated with pain levels.[9] It can detect and differentiate small and large changes in disability over time after surgery in patients with upper extremity musculoskeletal disorders. A 10-point difference in the mean DASH score might be considered as a minimally clinically relevant change.[50] The DASH score can reliably capture the limitations of patients on an individual item basis. Thus, the DASH can provide diagnosis-specific limitation profiles identifying disease-specific problems which are not recognizable from the summary DASH score, but which may be relevant for rehabilitation. In fact, if the limitation profile of a disease is known, therapy regimes can be tailored to this to improve the process and the outcome.[10]

The main limitations of the use of the DASH score to evaluate elbow function are related to its non-organ-specific nature, and to the large number of questions. For this reason, researchers have proposed a shorter version of DASH, the *Quick*DASH.[11] The *Quick*DASH has several advantages: can be compiled quickly, is easy to use and minimizes missing data. It shows reliability, validity and responsiveness when used for patients with either a proximal or a distal disorder of the upper extremity. The final version of the *Quick*Dash consists of items selected from the key domains identified in the theoretical framework of the DASH with the so called 'concept-retention approach'. Instead of 30 items, the *Quick*DASH uses 11 items to measure physical function and symptoms in people with any or multiple musculoskeletal disorders of the upper limb. Only one missing item can be tolerated, and, if two or more items are missing, the score cannot be calculated.[12] The optional modules (sports/performing arts and work) are retained as optional and have not changed from the original DASH. The *Quick*DASH is comparable with the full DASH: although there is a little loss of reliability, validity or responsiveness, its construct validity and responsiveness

suggest that this score should give views of disability and symptoms relatively similar to those provided by the full DASH.[11] Another study[12] has evaluated the performance of the *Quick*Dash and its cross-sectional and longitudinal validity and reliability by comparing this test with the DASH in the whole population and in different diagnostic groups. In this way, the study has demonstrated that the *Quick*DASH can be used instead of the DASH to measure disability/symptom severity with similar precision in a variety of arm disorders.

Other scores used in disorders of the musculoskeletal system (for example in shoulder, elbow or hand disorders) are the MFA and its short form, the SMFA.

Khalfayan *et al.*[38] have used this standardized elbow evaluation score in a study about treatment of Mason type II radial head fractures. This score has been also used by other authors.[39]

Most scores do not appear to have been constructed in a systematic fashion using recommended methodology. There is an increasing need for orthopaedic surgeons both to be familiar with and to routinely use objective measures of outcome for their procedures.[61] There is a trend towards the increased use of validated patient-based scores, but many have not been properly tested for validity, repeatability and sensitivity to change. Scores are not valid when used in a modified form and their use should be discouraged.[61] One of the further areas of study is to compare and contrast two or more scoring scales, to ascertain whether they address the same broad category of elbow function. To our knowledge, no such study has been performed in a systematic fashion. In a preliminary study, our group assessed the functional outcome of patients who had undergone elbow arthroscopy, evaluating the correlation between three elbow scoring systems and the patients' subjective perception of satisfaction as expressed by a simple satisfaction test and by a global visual analogue scale which investigate both pain and satisfaction. We have shown that there was no correlation between the results of the three scoring systems and patients' satisfaction: patients with the same level of satisfaction could perform differently at the scoring systems. However, the results of this study have not been published yet in a peer-reviewed journal.[62]

In conclusion, although many scoring systems have been used to evaluate elbow function, we are still far from a single outcome evaluation system which is reliable, valid and sensitive to changes of clinical importance, which takes into account both patients' and physicians' perspective and which is short and practical to use.

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