

FUNCTIONAL OUTCOME MEASURES AFTER DISPLACED INTRA-ARTICULAR CALCANEAL FRACTURES

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We have devised a new scoring system using visual analogue scales (VAS) to determine the functional outcome in 15 patients with 20 displaced intra-articular calcaneal fractures, confirmed by CT. The average follow-up was 19 months.

A VAS was completed separately by the patient, the surgeon and an independent assessor. It showed satisfactory agreement between observers and strong correlations with a General Health Survey (SF36), a pain scale (McGill Pain Questionnaire) and a disease-specific, historical scale for calcaneal fractures (the Rowe score).

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There has been a change in clinical research in orthopaedic surgery with regard to outcome measurements. The patient's view of daily activities and function at work or recreation is being emphasised (Flandry et al 1991; Kantz et al 1992; MacKenzie et al 1993) and there is less focus on physical measurements such as range of movement, strength, and time to weight-bearing. Methods to evaluate results after calcaneal fractures, however, have not been standardised or validated. Previous studies have used different modifications of Rowe's scale (Rowe et al 1963; Crosby and Fitzgibbons 1990; Buckley and Meek 1992).

We have developed a new functional outcome measure to evaluate these fractures. It uses visual analogue scales (VAS) (Katz and Melzack 1992) and combines the patient's

views with questions evaluating function.

Our aim was to validate the VAS for measuring the functional outcome of patients after calcaneal fractures.

PATIENTS AND METHODS

We studied 15 patients with 20 displaced intra-articular fractures of the posterior facet of the calcaneus, confirmed by CT (Table I). All were men and two-thirds were labourers at the time of injury. None had multiple injuries. Associated injuries included fractures of a lumbar vertebra (1), the ipsilateral lateral malleolus (1), and the contralateral tibial plafond (1). The patients were comparable with those in previous studies (Paley and Hall 1989; Miller 1990; Buckley and Meek 1992). Operative and non-operative methods of treatment were included. The fractures had occurred between June 1990 and February 1992 and were a consecutive series managed by the senior author (REB). There were no exclusion criteria. All patients were treated by early movement and physiotherapy, remaining non-weight-bearing for six weeks before progressing to walking.

Table I. Details of the 15 patients with 20 intra-articular calcaneal fractures

Age at time of injury in years (SD)	43 (13)
Age at follow-up in years (SD)	45 (13)
Time of follow-up in months (SD)	19 (7)
Side of injury	
Left	11
Right	9
Treatment	
Operative	12
Non-operative	8
Workman's compensation	
Yes	6
No	14

The patients completed the McGill Pain Questionnaire (Melzack 1975), the modified Rowe score (Table II; Buckley and Meek 1992), the SF36 Health Status Survey (Ware and Sherbourne 1992) and a VAS. The McGill Pain Questionnaire is an established, validated tool for the investigation of pain (Melzack and Torgerson 1971; Katz and Melzack 1992) and scoring was according to that already published (Katz and Melzack 1992). The modified Rowe score gives points in five categories and these add to give a total. The SF36 Health Status Survey has been validated

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PATIENT VISUAL ANALOGUE SCALE FORM

NAME: _____ DATE: _____
(day/month/year)
PATIENT I.D.#: _____
STUDY VISIT #: _____

For each question or statement below place a mark on the line between the two descriptions which you think describes your fractured heel relative to the two extremes.

The first five questions or statements refer to the amount of pain or discomfort you are having.

1. HOW OFTEN DOES YOUR HEEL/FOOT HURT?
Always _____ Never
2. HOW BAD IS THE PAIN IN YOUR HEEL/FOOT?
Pain as bad as it could be _____ No Pain
3. I HAVE HEEL/FOOT PAIN AT NIGHT MAKING IT DIFFICULT FOR ME TO SLEEP.
Always _____ Never
4. I HAVE STIFFNESS OR DISCOMFORT IN MY HEEL/FOOT IN THE MORNING WHEN I FIRST GET UP.
Always _____ Never
5. I HAVE ACHING IN MY HEEL/FOOT AT THE END OF THE DAY.
Always _____ Never

The following seven questions refer to your physical function.

6. I HAVE DIFFICULTY WALKING ON LEVEL GROUND.
Extreme Difficulty _____ No Difficulty
7. I HAVE DIFFICULTY WALKING ON ROUGH OR UNEVEN GROUND.
Extreme Difficulty _____ No Difficulty
8. I HAVE DIFFICULTY WALKING UP OR DOWN HILLS OR INCLINES.
Extreme Difficulty _____ No Difficulty
9. I HAVE DIFFICULTY WALKING LONG DISTANCES.
Extreme Difficulty _____ No Difficulty
10. I HAVE DIFFICULTY STANDING FOR PROLONGED PERIODS OF TIME.
Extreme Difficulty _____ No Difficulty
11. I HAVE DIFFICULTY RUNNING.
Extreme Difficulty _____ No Difficulty
12. I LIMP WHEN I WALK.
Always _____ Never

TAKING EVERYTHING INTO CONSIDERATION, RATE YOUR OVERALL RESULT FROM YOUR HEEL FRACTURE AT THIS POINT IN TIME ON THE FOLLOWING LINE.

The worst possible result _____ Perfect

Fig. 1

The VAS completed by the patient.

SURGEON AND INDEPENDENT ASSESSOR VISUAL ANALOGUE SCALE FORM

NAME: _____
DATE: (day/mo/yr) ____ / ____ / ____
PATIENT I.D. #: _____
STUDY VISIT #: _____

THE TREATING SURGEON WILL RATE EACH PATIENT ON THE FOLLOWING SCALES

1. THE FIRST SCALE REFERS TO THE AMOUNT OF PAIN THAT THE PATIENT IS HAVING.
Pain as bad as it could be _____ No Pain
2. THE SECOND SCALE REFERS TO GAIT AND RELATED ACTIVITIES.
Extreme Difficulty _____ No Difficulty
3. RATE THE OVERALL RESULT OF THIS FRACTURED CALCANEUS, AT THIS POINT IN TIME.
The worst possible result _____ Perfect

Fig. 2

The VAS completed by the surgeon and independent assessor.

(McHorney et al 1992) and used in orthopaedic studies (Kantz et al 1992). It is not disease-specific and allows comparisons with other conditions. The SF36 can be completed in five to seven minutes and was scored according to the methods published (International Resource Center 1992). The eight domains of the SF36 were averaged to yield a single value.

Our VAS had three sections: one was completed by the patient after some instruction (Fig. 1), one by the surgeon (Fig. 2), and an identical one by an independent assessor

Table II. Modified Rowe score for clinical evaluation

	Level	Score
Pain	None	30
	Exercise induced	25
	Mild on daily activity	20
	Pain with weight-bearing	10
	Pain at rest	0
Range of motion (per cent)	100 to 75	20
	74 to 50	10
	49 to 25	5
	24 to 0	0
Gait	Normal	15
	Mild limp (exercise)	10
	Moderate limp	5
	Severe limp	0
Activities	Normal	20
	Restricted on rough ground	15
	Moderate daily restrictions	10
	Able to walk short distances only	5
Work	Unable to walk	0
	No restrictions	15
	Some restrictions on usual occupation	10
	Change of job or substantial restrictions	5
Total	Unable to work	0
		100

Table III. Raw data of comparison of the VAS with the McGill Questionnaire, the SF36, and the modified Rowe score in 20 fractures

VAS							
Fracture	Patient	Retest patient	Surgeon	Independent assessor	McGill	SF36	Rowe
1	90	96	98	98	2	74	100
2	49		70	76	23	72	55
3	52		53	60	10	72	85
4	89	92	87	90	5	78	55
5	72		55	87	13		65
6	54	52	71	43	20	51	55
7	76		80	63	4	79	60
8	80		89	90	1	79	85
9	55	66	74	79	6	67	60
10	56	3	65	58	20	69	63
11	98	65	99	99	0	69	100
12	100		98	98	0	91	95
13	72		72	48	9	45	60
14	9	11	36	29	15	44	15
15	20	33	25	18	17	57	40
16	74	53	69	76	8	57	65
17	42	68	66	54	22	68	50
18	40		51	68	25	40	65
19	36		53	65	10	40	50
20	14		32	35	21	44	40
Mean	59	54	67	66	12	63	63
SD	26.9	29.3	21.5	23.9	8.3	15.3	21.4

who was an orthopaedic surgeon not involved in the care of the patient. The patient first completed his VAS form, and was then interviewed separately by the independent assessor and the surgeon for the completion of their VAS forms. The two interviewers had no access to the forms completed by the patient or by each other. A ruler was then used to measure the point, in millimetres, marked on the 10 cm scale, giving values of 0 to 100.

Informed consent was obtained before testing. The various scoring methods, including those for the surgeon and independent assessor, were assigned in a random manner. A research assistant instructed the patients on how to complete the forms and helped with any problems encountered.

Age, follow-up time, associated injuries, medical conditions and type of treatment were recorded. Each patient was given a second VAS form to complete at home two to four weeks later and return to the investigators.

Statistical analyses included an assessment of agreement between overall VAS results using Intraclass Correlation Coefficients (ICC) and plots comparing the differences between overall VAS results of two observers with the mean of the two results (Bland and Altman 1986). For comparisons between the patients' overall VAS result and the Rowe scale, the McGill Pain Questionnaire and the

SF36, Pearson correlation coefficients were used because these scales are different in nature. ICCs were used for the test-retest comparisons.

RESULTS AND DISCUSSION

As in other similar studies few of our patients had returned to their previous work (Paley and Hall 1989; Sangeorzan and Hansen 1990; Heckman 1991; Sanders et al 1993); the only two were one journalist and one farmer. A third had retired before the time of injury and a fourth was already on compensation for a previous injury. Six were unemployed and the others were employed in different or modified jobs.

Table III gives the raw data with means and standard deviations. Only eight of the 15 patients, representing 10 of 20 fractures, returned the follow-up VAS forms.

Table IV gives the statistical comparisons. Section one shows the ICCs of the overall VAS for each assessor as well as the test-retest data for the patients. An ICC of 0.80 or greater is considered to show an acceptable agreement (Landis and Koch 1977). Section two presents the Pearson correlation coefficients for the comparisons between the patients' overall VAS and the Rowe scale, the McGill Pain Questionnaire and the SF36.

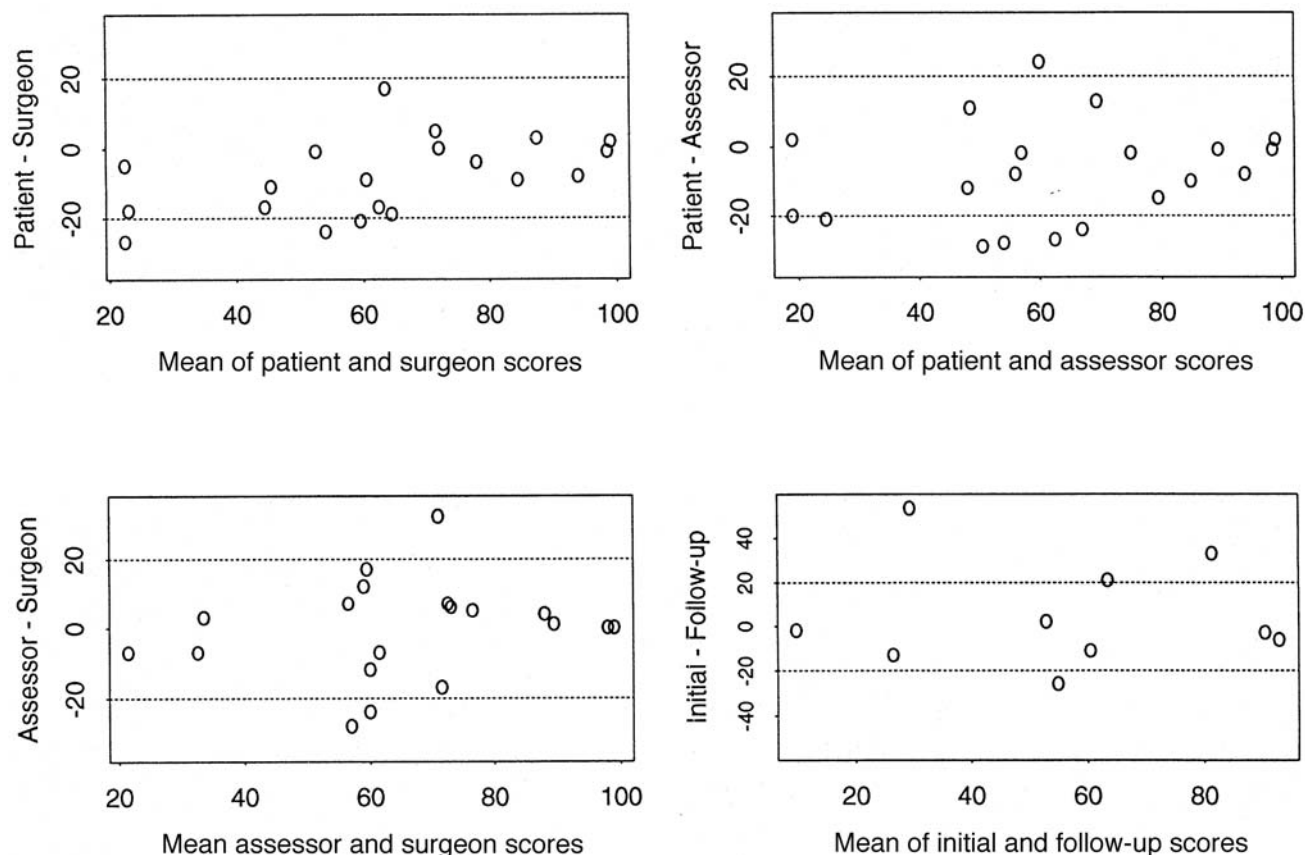


Fig. 3

Agreement comparisons of the VAS by the method of Bland and Altman (1986). Each graph plots the difference between two of the scorers on each patient against the mean of the two scores. The dotted lines show a 20-point difference between the two scores.

Figure 3 shows the agreement comparisons of the VAS using the method of Bland and Altman (1986). Each graph plots the difference between scores for two assessors on each patient (ordinate) against the mean of the two scores (abscissa). The dotted lines represent a 20-point difference between the two assessors. This method is used only on similar scales where the numbers are comparable or have similar meaning. We used it only for comparisons of VAS scores.

There were few problems with completion of the forms, except that one patient filled in only one side of the SF36 form and a second was unable to read English well enough. The research assistant read the forms to him and he marked the appropriate responses. There were no consistent problems with understanding the forms.

VAS scores. The newly developed VAS for the patient, surgeon and independent assessor showed satisfactory interobserver agreement with ICCs ranging from 0.818 to 0.895 (Table IV), greater than the acceptable level of 0.80 (Landis and Koch 1977). Assessment of the agreement by the method of Bland and Altman (1986) (Fig. 3) showed that at the high numbers of the scale (right), where the clinical results were best, differences were small. At the lower numbers of the scale (left), where the clinical results

Table IV. Statistical comparisons of scores of the VAS, the McGill Questionnaire, the SF36 and the modified Rowe score

1. Visual analogue score	Intraclass correlation coefficient
Patient v independent assessor	0.836
Independent assessor v surgeon	0.818
Patient v surgeon	0.895
Patient test v retest	0.690
2. Patient VAS v other scores	Pearson correlation coefficient
VAS v McGill pain questionnaire	-0.748
VAS v Rowe	0.813
VAS v SF36	0.692

were the poorest, differences between the surgeons were small but those between either surgeon and the patient were larger. In two cases the patient scored 20 points less than the surgeons. All observers had prior knowledge of an excellent result, a non-injured calcaneus. By contrast, only the surgeons would be expected to have knowledge of poorer results hence the difference between observers at the lower end of the VAS. The middle range of results showed a relatively larger variation which illustrates the difficulty in assessing results in this region.

Repeat VAS. The second part of the validation for the VAS studied repeatability of measures. Over one-half of the patients representing one-half of the fractures returned repeat VAS results. The ICC was 0.690. Table III and Figure 3 show some large differences for which there are four possible explanations. First, although at this point it was at least ten months from the injury and the average follow-up time was 19 months, the patients' improvement may not have been as static as anticipated. Secondly, the measurement tool may have been too sensitive, especially in the mid-range compared with the lower or higher ends and the VAS results may reflect day-to-day variation. This sensitivity could explain the differences between the observers in the mid-range mentioned earlier. The third possibility may have been the small numbers of returned VAS forms, which accentuated the large variations in the forms returned. Finally, the first testing session may have biased the subsequent evaluation by the patients.

VAS and other scales. The third part of the process involved comparing the patients' overall VAS results with those of other scales. The highest Pearson correlation coefficient (0.813) for the subject VAS was with the disease-specific modified Rowe score (Buckley and Meek 1992). This was expected since both scales have similar types of questions for pain and function, but use different scoring methods. The McGill Pain Questionnaire had the next strongest correlation value (-0.748), in the appropriate direction since higher numbers for this scale mean poorer results, the opposite of all other scales. This scale evaluates only pain whereas the other three try to incorporate function with pain in different forms. The correlation indicates that pain is an important factor in evaluating outcomes in patients with displaced intra-articular calcaneal fractures. The overall score for the SF36 had a correlation of 0.692 with the patients' overall VAS. Of the eight domains of the SF36, the highest correlation (0.671) was with social factors.

Advantages of the VAS include its wide range of response, ease of administration and scoring, and speed of completion (Katz and Melzack 1992). The VAS has been validated for pain (Carlsson 1983; Price et al 1983), subjective feelings (Bond and Lader 1974) and mood measures (Cella and Perry 1986) and has recently been introduced to orthopaedic studies (Labib, Fisher and Laurin 1986; Flandry et al 1991). Our example includes patient input which considers function and pain, and focuses less on traditional endpoints (range of movement, strength, etc.).

The patient's viewpoint in evaluating outcomes after injury is important (Ware and Sherbourne 1992; MacKenzie et al 1993). Other factors such as the social and economic environment also affect the results (MacKenzie et al 1993); these were often neglected by disease-specific scales. This is where the use of general health surveys, such as the SF36, is valuable.

Conclusion. We feel that the VAS is a good functional outcome measure for displaced intra-articular calcaneal fractures. It has acceptable interobserver agreement and

strong correlations with disease-specific scales and validated general health and pain surveys.

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REFERENCES

- Bond A, Lader M. The use of analogue scales in rating subjective feelings. *Br J Med Psychol* 1974;47:211-8.
- Bland JM, Altman DG. Statistical methods for assessing agreement between two methods of clinical measurement. *Lancet* 1986;i:307-10.
- Buckley RE, Meek RN. Comparison of open versus closed reduction of intra-articular calcaneal fractures: a matched cohort in workmen. *J Orthop Trauma* 1992;6:216-22.
- Carlsson AM. Assessment of chronic pain. I. Aspects of the reliability and validity of the visual analogue scale. *Pain* 1983;16:87-101.
- Cella DE, Perry SW. Reliability and concurrent validity of three visual-analogue mood scales. *Psychol Rep* 1986;59:827-33.
- Crosby LA, Fitzgibbons T. Computerized tomography scanning of acute intra-articular fractures of the calcaneus: a new classification system. *J Bone Joint Surg [Am]* 1990;72-A:852-9.
- Flandry F, Hunt JP, Terry GC, Hughston JC. Analysis of subjective knee complaints using visual analogue scales. *Am J Sports Med* 1991;19:112-8.
- Heckman JD. Fractures and dislocations of the foot. In: Rockwood CA Jr, Green DP, Bucholz RW, eds. *Fractures in adults*. 3rd ed. Philadelphia, etc: JB Lippincott Co, 1991:175-89.
- International Resource Center for Health Care Assessment. *How to score the MOS 36-item short-form health survey (SF36)*. Boston: New England Medical Center Hospitals (Box 345, 750 Washington Street, Boston MA 02111), 1992.
- Kantz ME, Harris WJ, Levitsky K, Ware JE, Davies AR. Methods for assessing condition-specific and generic functional status outcomes after total knee replacement. *Med Care* 1992;30 (Suppl 5):240-52.
- Katz J, Melzack R. Measurement of pain. *Anesthesiology Clinics of North America* 1992;10:229-46.
- Labib S, Fisher W, Laurin CA. The use of visual analogue scales (VAS) in assessment of pain and function in arthroplasty patients (abstract). *Orthop Trans* 1986;10:598.
- Landis JR, Koch GG. The measurement of observer agreement for categorical data. *Biometrics* 1977;33:159-74.
- MacKenzie EJ, Burgess AR, McAndrew MP, et al. Patient-oriented functional outcome after unilateral lower extremity fracture. *J Orthop Trauma* 1993;7:393-401.
- McHorney CA, Ware JE, Rogers W, Raczek AE, Lu JF. The validity and relative precision of MOS short- and long-form health status scales and Dartmouth COOP charts. *Med Care* 1992;30 (Suppl 5):253-65.
- Melzack R. The McGill pain questionnaire: major properties and scoring methods. *Pain* 1975;1:277-99.
- Melzack R, Torgerson WS. On the language of pain. *Anesthesiology* 1971;34:50-9.
- Miller ME. Surgical management of calcaneus fractures: indications and techniques. In: Greene WB, ed. *AAOS Instructional Course Lectures*. American Academy of Orthopaedic Surgeons, 1990;XXXIX:161-5.
- Paley D, Hall H. Calcaneal fracture controversies: can we put Humpty Dumpty together again? *Orthop Clin North Am* 1989;20:665-77.
- Price DD, McGrath PA, Rafii A, Buckingham B. The validation of visual analogue scales as ratio scale measures for chronic and experimental pain. *Pain* 1983;17:45-56.
- Rowe CR, Sakellarides HT, Freeman PA, Sorbie C. Fractures of the os calcis: a long-term follow-up of 146 patients. *J Am Med Assoc* 1963;184:920-3.
- Sanders R, Fortin P, DiPasquale T, et al. The results of operative treatment of displaced intra-articular calcaneal fractures using a CT scan classification. In: Tscherne H, Schatzker J, ed. *Major fractures of the pilon, talus, calcaneus*. New York, etc: Springer-Verlag, 1993:175-89.
- Sangeorzan BJ, Hansen ST Jr. Ankle and foot: trauma. In: Poss R, et al, ed. *Orthopedic knowledge update 3: home study syllabus*. Park Ridge IL: American Academy of Orthopaedic Surgeons, 1990:619-24.
- Ware JE, Sherbourne CD. The MOS 36-item short-form health survey (SF36). I. conceptual framework and item selection. *Med Care* 1992;30:473-83.