Factors determining quality of life and level of sporting activity after internal fixation of an isolated acetabular fracture

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We investigated whether patients who underwent internal fixation for an isolated acetabular fracture were able to return to their previous sporting activities.

We studied 52 consecutive patients with an isolated acetabular fracture who were operated on between January 2001 and December 2002. Their demographic details, fracture type, rehabilitation regime, outcome and complications were documented prospectively as was their level and frequency of participation in sport both before and after surgery. Quality of life was measured using the EuroQol-5D health outcome tool (EQ-5D).

There was a significant reduction in level of activity, frequency of participation in sport (both $p < 0.001$) and EQ-5D scores in patients of all age groups compared to a normal English population ($p = 0.001$). A total of 22 (42%) were able to return to their previous level of activities: 35 (67%) were able to take part in sport at some level. Of all the parameters analysed, the Matta radiological follow-up criteria were the single best predictor for resumption of sporting activity and frequency of participation.

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The treatment of acetabular fractures has improved significantly over the last three decades,¹⁻³ resulting in better outcomes despite the fact that injuries from high-energy trauma usually leave a significant degree of disability.^{4,5} A number of studies^{6,7} have shown that posterior wall fractures are commonly associated with inferior results.^{8,9}

Acetabular fractures usually occur in young active people, with motor vehicle accidents the most common mechanism of injury.¹⁰ There is a little information about the ability of these patients to return to sports. The purpose of this study was to investigate the level of participation in sport and quality of life after surgical treatment of an isolated acetabular fracture.

Patients and Methods

After receiving approval from the hospital ethics committee, we identified 120 skeletally mature patients who were treated operatively for an isolated acetabular fracture between January 2001 and December 2002. Patients with an associated nerve injury or other skeletal injuries were excluded. Patients with pathological fractures, systemic inflammatory disease or pre-existing musculoskeletal disability were also excluded. This left 52 patients who were eligible for inclusion in the study. There were 48 males and four females with a mean age of 43 years (16 to 80).

Initial assessment. Primary and secondary surveys were carried out according to the Advanced Trauma Life Support (ATLS) protocol.¹¹ All patients were treated surgically according to their physiological status.^{12,13} Standard radiographs, consisting of an anteroposterior and two 45° oblique Judet views, and CT scans were obtained for each patient.^{14,15} The fracture pattern was classified using the Letournel system.¹⁶

Treatment. The indications for surgery included displacement of fracture fragments by more than 2 mm, dislocation of the hip with a posterior wall fracture, articular surface impaction or depression, intra-articular fragmentation or any fracture involving more than 30% of the posterior wall, as assessed from the pre-operative CT scan.^{5,14,17,18} Patients were generally treated within three to five days of presentation.¹⁹

A radiolucent OSI table (Orthopaedics Systems Inc., Union City, California) and the Matta plating system (Stryker, Trauma AG, Selzach, Switzerland) were used routinely in all cases. A Kocher-Langenbeck²⁰ approach was employed in 38 patients and the ilioinguinal approach in 12. Percutaneous screw fixation was used in two cases.

Each patient received one pre- and post-operative dose of prophylactic antibiotic (cefuroxime, 750 mg) as well as methicillin-resistant *staphylococcus aureus* (MRSA) prophylaxis

Table I. Scoring systems used to evaluate the level and the frequency of activity

Scoring system for evaluating the level of activity (Grimby's scale) ³¹	Scoring system for evaluating the frequency of sports practice
1. Hardly any physical activity	1. Never
2. Mostly sit, occasional walk or gardening	2. Infrequent
3. Light exercise	3. Once or twice per month
4. Moderate exercise: < 2 h per week	4. Once or twice per week
5. Moderate exercise: at least three hours per week	5. Daily
6. Regular hard exercise	

(mupirocin daily for five days). Low-molecular weight heparin (Clexane 40 mg, Sanofi/Aventis, Guildford, United Kingdom), and intermittent pneumatic compression devices were used for thromboprophylaxis, instituted peri-operatively and continued for a period of six weeks.²¹ Indometacin (25 mg three times daily) was started within 24 hours of operation and continued for four weeks post-operatively for the prevention of heterotopic ossification (HO) if the Kocher-Langenbeck approach had been used.²²

The quality of operative reduction of the fractures was evaluated radiologically, two to five days post-operatively, based on the Matta²³ criteria: anatomical (0 mm to 1 mm displacement), imperfect (2 mm to 3 mm displacement), and poor reduction (> 3 mm displacement). In addition, the radiological outcome, obtained at the last follow-up examination, was also graded according to the Matta criteria:²⁴ excellent, indicating a normal appearance of the hip joint; good, indicating mild arthritic changes (small osteophytes, 1 mm narrowing of the joint space and minimal subchondral sclerosis); fair, indicating intermediate changes (moderate-sized osteophytes, < 50% narrowing of the joint space and moderate subchondral sclerosis); and poor, indicating advanced arthritic changes (large osteophytes, > 50% narrowing of the joint space and collapse of the femoral head and acetabulum). The three standard plain radiographs were used for these assessments.

In 34 patients (65%), post-operative CT was carried out to assess the quality of reduction and to exclude penetration of the joint by the internal fixation. However, for the purposes of this study, the quality of operative reduction of the fracture was only evaluated radiologically.

HO characterised by the Moed and Smith¹⁵ modification of Brooker's classification²⁵ (0, I and II, consistent with normal or nearly normal hip movement indicating mild HO, and III and IV associated with loss of movement, indicating severe HO). Avascular necrosis of the femoral head (AVN) was graded using the Ficat and Arlet²⁶ classification.

Two experienced radiologists (PVG, CSR) evaluated all the radiographs according to the Matta criteria. Both were blinded to the pre-operative, operative, and post-operative patient clinical details. If there was disagreement, the opinion of a third radiologist was sought.

Clinical evaluation. Quality of life was assessed using the generic EuroQol-5D questionnaire (EQ-5D).^{27,28} The EQ-5D

descriptive system consists of five dimensions of health, namely mobility, self-care, usual activities, pain/discomfort and anxiety/depression. Each dimension consists of three levels: no problems, some/moderate problems, and extreme problems. The EQ-5D utility scores were calculated on the basis of coefficients derived from time-trade-off evaluation studies²⁹ and compared to normative values from the 1996 Health Survey for England.³⁰

The level of activity was evaluated according to Grimby's six-grade scale.³¹ Participation and infrequency of sports practice were evaluated as previously described by Narvani et al.³² More specifically, patients were interviewed and asked to complete a questionnaire listing all their sporting activities before and after surgery. They were also asked to document the changes to sporting activities that occurred as a result of their injury (no change, restriction, stopped completely). The frequency of sports practice was assessed using a five-point scale (1 = never, 5 = daily) pre-operatively and at the last follow-up³² (Table I).

Post-operative management. Post-operatively, each patient carried out passive and active exercises of the affected hip, with progressive resistance exercises of the adductors, quadriceps and hamstrings. They mobilised toe-touch weight-bearing for a period of 12 weeks before progressing to full weight-bearing. At this stage, patients were referred to physiotherapy for gait re-education, pelvic floor exercises and hip muscle strengthening exercises. As mobility and proprioception of the hip joint steadily improved, patients were advised to progress to non-impact exercises such as cycling, swimming, running in the pool and light weight-training. After a year, all patients were allowed to return to all normal activities, provided these were tolerated.

Clinical and radiological follow-up was performed at four, six, 12 months, and annually thereafter.

Statistical analysis. All analyses were made in an exploratory fashion. According to the quality of data, we calculated means, medians, SD, proportions and risks, with their appropriate measures of distribution and 95% confidence intervals (CI) where suitable. We used paired cross-table analyses to investigate differences between pre- and post-operative sports activity and frequency levels. Ordered logistic regression was applied to identify possible predictors of the degree of recovery. Because odds ratios (OR) from ordered logistic regression may be difficult to

Table II. Quality of reduction, radiographic grade and sports participation according to fracture type

	Fracture type					Total (%)
	Anterior column (n = 5)	Posterior column (n = 2)	Posterior wall (n = 26)	Posterior column + posterior wall (n = 3)	Both columns (n = 16)	
Quality of reduction						
Anatomical (0 mm to 1 mm)	3	2	23	3	12	43 (83)
Imperfect (2 mm to 3mm)	2	-	3	-	4	9 (17)
Poor (> 3 mm)	-	-	-	-	-	-
Radiographic grade						
Excellent	3	1	14	2	11	31 (60)
Good	2	1	7	1	2	13 (25)
Fair	-	-	1	-	-	1 (1.9)
Poor	-	-	4	-	3	7 (13)
Return to sport						
Same	3	-	11	1	7	22 (42)
Restriction	2	-	10	1	7	20 (38)
Stopped	-	2	5	1	2	10 (19)

Table III. Differences between pre- and post-operative Grimby levels of sports activity

Pre-operatively	Grimby level post-operative						Totals
	1	2	3	4	5	6	
2	1	2	0	0	0	0	3
3	1	4	3	0	1	0	9
4	2	2	0	3	0	0	7
5	2	1	5	2	9	0	19
6	1	3	0	0	5	5	14
Totals	7	12	8	5	15	5	52

Table IV. Differences between pre- and post-operative frequency of sports³¹

Pre-operatively	Frequency of sport post-operative					Totals
	1	2	3	4	5	
2	2	5	0	1	0	8
3	5	2	1	0	0	8
4	6	4	2	14	0	26
5	2	1	0	3	4	10
Totals	15	12	3	18	4	52

interpret clinically, we dichotomised differences between pre- and post-operative values. Recovery was assumed in case of sports activities reduced by a maximum of one level, whereas impaired sports activity was indicated by a reduction of one level or more. These binary outcomes were analysed by univariate logistic regression.

Variables influencing EQ-5D utility scores and its visual analogue scale (VAS) were evaluated by linear regression. STATA 10.0 software (Stata Corp LP, College Station, Texas) was used for all analyses. Statistical significance was set at a p-value of < 0.05.

Results

The median follow-up was 36 months (24 to 72). Radiological classification revealed 26 (50%) posterior wall, 16 (31%) two-column, five (10%) anterior column, three combined posterior wall and column (6%) and two posterior column fractures (4%). In all, 14 patients (27%) reported regular hard exercise (Grimby level 6), and another 19 (37%) reported moderate exercise of at least three hours per week (level 5) before their fracture. Moderate (level 4), light (level 3), and occasional (level 2) sports activities were reported by seven, nine and three patients, respectively.

Radiological evaluation. Anatomical reduction was achieved in 43 patients (83%) and an imperfect reduction in nine (17%). At the final follow-up, 31 patients (60%) had excellent, 13 (25%) had good, and eight (15%) had fair or poor radiographic results (Table II).

A total of 14 patients developed HO after surgery, giving a risk of 27% (95% CI 16 to 41), of whom five had severe HO, with more than 20% loss of movement.¹⁵ AVN occurred in another five patients (one patient with type 3, two type 2 and two type 1) (10%, 95% CI 3 to 21).

Clinical outcomes. Tables III and IV summarise the distribution of pre- and post-operative sports activities. Cross-table analysis showed a significant reduction in the activity

Table V. Influence of demographic details and fracture characteristics on sports activity and frequency

	Activity*			p-value	Frequency			p-value
	OR	95% CI			OR	95% CI		
Fracture type	1.59	0.79	3.20	0.189	1.36	0.72	2.59	0.342
Age (yrs)	0.99	0.96	1.03	0.661	0.98	0.95	1.02	0.339
Male gender	0.67	0.06	6.93	0.734	0.61	0.06	6.31	0.677
Length of follow-up (yrs)	1.01	0.97	1.05	0.786	1.00	0.96	1.04	0.854
Anatomical reduction	2.21	0.72	6.80	0.166	2.88	0.67	12.51	0.157
Matta criteria†	2.89	1.23	6.28	0.014	2.48	1.12	5.51	0.025
Onset of avascular necrosis	0.70	0.11	4.66	0.715	0.31	0.05	2.07	0.228
Presence of heterotopic ossification	1.46	0.69	3.08	0.327	1.07	0.57	2.00	0.838

* OR, odds ratio; 95% CI, 95% confidence interval

† latest follow-up

Table VI. Influence of demographic details and fracture characteristics on EQ-5D assessment analysed with linear regression analysis

	EQ-5D VAS*			p-value	EQ-5D utility score			p-value
	b	95% CI			b	95% CI		
Fracture type	2.20	3.63	8.03	0.453	0.01	-0.08	0.10	0.777
Age (yrs)	-0.23	-0.58	0.12	0.19	0.00	-0.01	0.00	0.225
Male gender	-9.17	-30.29	11.96	0.388	-0.16	-0.49	0.17	0.345
Length of follow-up (yrs)	-0.05	-0.43	0.33	0.796	0.00	-0.01	0.00	0.728
Anatomical reduction	10.59	-4.09	25.28	0.154	0.15	-0.08	0.38	0.204
Matta criteria†	6.82	1.66	11.97	0.011	0.10	0.02	0.18	0.014
Onset of avascular necrosis	-12.77	-31.66	6.13	0.181	-0.31	-0.60	-0.02	0.038
Presence of heterotopic ossification	-2.97	-9.01	3.07	0.328	-0.02	-0.11	0.08	0.731

* VAS, visual analogue scale; 95% CI, 95% confidence interval

† latest follow-up

($p < 0.001$) and frequency ($p < 0.001$) of sports for the group as a whole. However, 22 patients (42%) fully regained their previous level of sporting activity. Another 12 reported a reduction, but by only one level, and one patient increased activity by two levels. Thus, sports activity continued in 35 patients (67%, 95% CI 53 to 80). Specifically, 21 of 33 patients (64%, 95% CI 45 to 80) with pre-operative Grimbly levels 5 or 6 returned to full activity or dropped only one level from their pre-operative activity level.

Similar results were seen when the frequency of sporting activity was studied: with 34 patients (65%, 95% CI 51 to 78) recovering fully, or with a deficit of one level.

The Matta radiographic follow-up criteria were the single best predictor for resumption of sporting activity and frequency (Table V). Patients who recovered to their pre-operative level of sports activities and frequency were, respectively seven (OR 6.94, 95% CI 1.29 to 37.49) and nine times (OR 8.63, 95% CI 1.44 to 51.72), more likely to have had an excellent radiological result than a poor or fair one.

The mean EQ-5D utility score was 0.73 (95% CI 0.64 to 0.82), which was lower than the population norm (0.85, 95% CI 0.84 to 0.85) ($p = 0.001$). The mean EQ-5D VAS was 71.5 (95% CI 65.9 to 77.2). Again, the Matta radiographic follow-up criteria showed a significant impact on clinical outcomes (Table VI).

Utility scores in the 31 patients with excellent radiographic results were close to the population norm (0.81, 95% CI 0.71 to 0.92), but were markedly reduced in those with poorer results (0.61, 95% CI 0.47 to 0.76) ($p < 0.05$). The findings were similar with VAS ratings (77.9, 95% CI 71.3 to 84.5 compared to 62.1, 95% CI 53.1 to 71.2, respectively). Of the patients with severe HO (grade III), two were able to return to their previous sporting activities, two continued sports but with some restriction, and only one had to stop altogether. Three patients with grade I or II HO also stopped their sporting activities.

One patient who developed grade 2 AVN (both grade I) continues to take part in sports without restriction. Two patients with AVN continue to undertake sport at a reduced level and frequency, and two have stopped playing sport altogether (one each grade 2 and 3).

Discussion

We observed a significant reduction in the level of activity and frequency of sport undertaken in patients who underwent internal fixation for an isolated acetabular fracture. Nevertheless, 42% were able to return to their previous level of activities, and 67% were able to participate in sport at some level. The Matta radiological follow-up criteria were the single best predictor for resumption of sport at the pre-injury activity level and frequency.

Fractures of the acetabulum are most common in young, active people³³ and are known to be associated with a high degree of disability and poor functional outcome owing to the variable degree of involvement of the hip joint.³⁴⁻³⁶ Several scoring systems have been developed to evaluate the outcome of treatment and recovery.^{4,5,8,9,34,37-40} The modified Merle D'Aubigné clinical hip score⁴¹ is generally accepted for assessing the outcome after such injuries.^{5,23,42} The musculoskeletal function assessment is a 101-item self-administered health-status instrument designed for patients with disorders or injuries of the musculoskeletal system.⁴³ The Short Form-36^{44,45} Western Ontario and McMaster Universities Osteoarthritis Index⁴⁶ and the Harris Hip Score⁴⁷ have also been used. However, there is no specific assessment score which evaluates return to previous sporting activities in this group of patients.

We chose to use the six-grade Grimby scale to evaluate level of activity, a simple five-grade scale to assess the frequency of participation in sport, and the generic EuroQol-5D questionnaire to assess the quality of life. The Grimby scale³¹ was proposed in 1986, since when it has often been used to assess the level of activity of patients who have undergone hip or knee surgery^{48,49} or sustained other types of fracture or injury,^{50,51} and for research purposes.⁵²⁻⁵⁵ The five-grade scale has been used to assess involvement in sports after hip resurfacing.³² The EQ-5D has not previously been used to assess quality of life in patients with acetabular fractures, but has been used for the evaluation of other musculoskeletal injuries of the lower limb and has been considered a reliable method of assessing outcome from femoral neck fractures.⁵⁶⁻⁵⁸ In our study, patients of all age groups had a significant reduction in EQ-5D scoring compared to a normal England population when adjusted for age. Again, the Matta criteria showed a significant impact on clinical outcome.

The outcome of operative treatment of acetabular fractures is determined by many factors.¹ These include the quality of reduction,^{3,23,59-61} the age of the patient,^{5,23,62} the degree of damage to the femoral head,^{4,23,62,63} damage to the sciatic nerve, HO, and osteonecrosis of the femoral head.^{23,62} In a series of 180 acetabular fractures treated by open reduction and internal fixation, the factors found to be related to an adverse outcome were local complications, imperfect fracture reduction, associated fracture type, and HO.⁶² Elsewhere, predictors of a better outcome were found to be a patient less than 40 years old, a simple fracture as defined by Judet and Letournel,⁴² and the absence of damage to the femoral head.⁴

In this study, the five patients (19%) with a posterior wall fracture had a fair or poor final radiological outcome (Table II). However, statistical analysis revealed that fracture pattern was not a significant predictor for the resumption of sports activity and frequency (Tables V and VI). This finding should, however, be considered with caution, as the small group of patients studied could have given rise to a type II statistical error, as not all fracture patterns were represented in the series. In addition, the results of linear regression analysis must be interpreted in the light of this limited pattern of exposure. For example, if patients with T-type and other fractures had been included,

they might have affected the EQ-5D VAS and utility scores as well.

In all 14 patients (27%) developed HO, and in five this was 'severe'. This supports our previous meta-analysis,¹ which found the incidence of HO after surgery for acetabular fractures to be 25.6%. The incidence of AVN in our series was 10% compared with 3% to 53% in other published series.⁶⁴⁻⁶⁶ This wide variation can be attributed to the individual study design, in particular the length of follow-up, and the fact that in most series the diagnosis of AVN was based on plain radiographs.

This study represents the experience of a single tertiary referral centre with a standard treatment protocol. However, it is limited by the number of participants. This is due in part to the relative rarity of acetabular fractures, but also to our exclusion of simultaneous musculoskeletal injuries to avoid assessment bias. Another limitation is the wide age range. We included very young patients and six patients who were over 65 years old. The inclusion of older patients could be considered a drawback, but in another study the pre-operative sporting profiles of patients undergoing primary joint replacement found that more than 20% of patients aged 80 years were participating in sport before surgery.⁶⁷ Accordingly, we believe that the inclusion of patients over 65 years of age is justifiable, given ongoing demographic changes and the increasing life expectancy of our patients. We did not find age to be a significant predictor for resumption of sporting activities.

In conclusion, although two-thirds of the patients were able to return to sports, many had to reduce their level and frequency of activity. Further studies are needed to investigate whether a return to impact sports should be avoided in an effort to prolong the longevity of the reconstructed hip joint, and reduce the likelihood of subsequent joint replacement.

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