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Hip Function after Surgically Treated Isolated Traumatic Acetabular Fracture: A Prospective Series of Consecutive Cases

Indy Smits, PT, MSc, Niek Koenders, PT, PhD, Vincent Stirler, MD, PhD*, Erik Hermans, MD, PhD*

Department of Rehabilitation, Radboud University Medical Center, Nijmegen, the Netherlands
*Department of Surgery, Radboud University Medical Center, Nijmegen, the Netherlands**

Purpose: Isolated acetabular fractures can occur as a result of a high energy impact on the hip joint. Surgery is required for most patients with an isolated acetabular fracture in order to alleviate pain, restore joint stability, and regain hip function. This study was conducted in order to examine the course of hip function in patients after surgical treatment of an isolated traumatic acetabular fracture.

Materials and Methods: This prospective series of consecutive cases included patients who underwent surgery for treatment of an isolated acetabular fracture in a European level one trauma center between 2016 and 2020. Patients with relevant concomitant injuries were excluded. Scoring of hip function was performed by a trauma surgeon using the Modified Merle d'Aubigné and Postel score at six-week, 12-week, six-month, and one-year follow-up. Scores between 3-11 indicate poor, 12-14 fair, 15-17 good, and 18 excellent hip function.

Results: Data on 46 patients were included. The mean score for hip function was 10 (95% confidence interval [CI] 7.09-12.91) at six-week follow-up (23 patients), 13.75 (95% CI 10.74-16.76) at 12-week follow-up (28 patients), 16 (95% CI 13.40-18.60) at six-month follow-up (25 patients), and 15.50 (95% CI 10.55-20.45) at one-year follow-up (17 patients). After one-year follow-up, the scores reflected an excellent outcome in 11 patients, good in five patients, and poor in one patient.

Conclusion: This study reports on the course of hip function in patients who have undergone surgical treatment for isolated acetabular fractures. Restoration of excellent hip function takes six months.

Key Words: Acetabulum, Hip joint, Articular range of motion, Pain, Activities of daily living

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Address reprint request to
Indy Smits, PT, MSc
(https://orcid.org/0000-0002-0462-2494)
Department of Rehabilitation, Radboud University Medical Center, Reinier Postlaan 4, 6525 GC Nijmegen, the Netherlands
TEL: +31-623566947
E-mail: indy.smits@radboudumc.nl

INTRODUCTION

Although relatively uncommon, acetabular fractures are typically a result of a high-energy impact injury to the hip joint, such as the types of injuries sustained in traffic accidents, falls from heights, or bicycle accidents[1]. Surgical intervention is often recommended for restoration of hip joint function and to prevent post-traumatic arthritis[2,3]. However, surgical management of acetabular fractures can involve extensive dissection of the surrounding muscles, leading to development of muscle weakness and gait disorders[4-6]. These disorders can cause pain and reduced mobility, which

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can have a significant impact on the patient's quality of life[7]. Despite numerous studies reporting on the short- and long-term outcomes of open reduction and internal fixation (ORIF) for treatment of acetabular fractures, there is a lack of understanding of the recovery process following surgical treatment for isolated acetabular fractures[8]. Acquiring such knowledge is essential for healthcare professionals in order to provide accurate prognoses, educate patients, and to be alert to signs of abnormal recovery. To address this gap in knowledge, the aim of this study is to examine the course of hip function from six weeks post-surgery to one-year follow-up in patients who have undergone surgery for treatment of an isolated acetabular fracture.

MATERIALS AND METHODS

1. Design

This single center study of a prospective series of consecutive cases was conducted at the Pelvic Expert Center of a European level one trauma center. Data from up to one-year follow-up on patients who underwent ORIF for treatment of isolated traumatic acetabular fractures between 2016 and 2020 were retrieved. This study was conducted according to guidelines established by the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement[9]. According to Dutch legislation, approval from a medical ethical committee was not required.

2. Patients

Patients who 1) were ≥16 years old; 2) had an isolated traumatic acetabular fracture; 3) had undergone ORIF of the acetabulum; and 4) were treated according to our standard of care outpatient protocol (10% loading of the affected leg six weeks after surgery and 100% loading of the affected leg after six weeks following surgery) were included in this study. Patients who were transferred to another hospital, received non-surgical treatment, or had concomitant injuries (e.g., brain injury, and fractures of the upper or lower extremities) that might interfere with rehabilitation were excluded. All surgeries were performed by the two senior authors, who are part of a team of six specialized pelvic trauma surgeons in our hospital.

3. Data Collection

Data collected included patients' clinical characteristics, fracture type as classified by Judet and Letournel, complications related to surgery, and clinical scoring of the Modified Merle d'Aubigné and Postel score during follow-up at six weeks, 12 weeks, six months, and one year. The Modified Merle d'Aubigné and Postel score is used for assessment of the pain, gait, and range of motion of the hip, each with a maximum score of 6 points. The final clinical score is determined by the sum of the three individual scores. A total score of 18 is defined as excellent, 15 to 17 as good, 12 to 14 as fair, and 3 to 11 as poor[10]. During the follow-up period, the Modified Merle d'Aubigné and Postel score was completed by the treating trauma surgeon during outpatient visits.

4. Statistical Analysis

Descriptive statistics were expressed as means with standard deviation (SD) or 95% confidence interval (CI). A sensitivity analysis was applied after multiple imputation for missing data by chained equations. Multiple imputation is a widely used method for management of missing data. When using this approach, the goal is to account for the uncertainty surrounding missing data by generating multiple versions of the data, each having different plausible values for the missing data. These imputed datasets are then used to obtain the results and combine them in an appropriate manner[11]. The primary results were compared with the results of the sensitivity analyses. Data-analysis was performed in IBM SPSS Statistics (ver. 27; IBM).

RESULTS

1. Patients

A total of 157 patients underwent treatment for an acetabular fracture between January 2016 and May 2020. Sixteen patients (10.2%) died of unknown causes during follow-up, three patients (1.9%) who were transferred to another hospital were lost to follow-up, and 42 patients (26.8%) received non-surgical treatment. A total of 96 patients (61.1%) underwent surgical treatment; however, 50 of these patients were excluded because of relevant concomitant injuries (e.g., brain injury, and fractures of the upper or lower extremities). Ultimately, 46 patients met the inclusion criteria.

The characteristics of the 46 included patients (47.9%) are shown in Table 1. The mean age of the included patients was 51±19 years. The included patients ranged in age between 17 and 83 years. Post-surgical sciatic nerve neu-

rapraxia was detected in one patient (2.2%). Seven patients (15.2%) were suffering from post-traumatic arthritis of the hip one year after surgery; one patient received non-surgical treatment and six patients underwent total hip arthroplasty with acetabular fixation. One year after surgery, Brooker 3 classification of heterotopic ossification without clinical symptoms was detected in one patient.

Table 1. Patient Characteristics (n=46)

Variable		Value
Age (yr)		51±19
	<60	30 (65.2)
	≥60	16 (34.8)
Sex	Male	36 (78.3)
	Female	10 (21.7)
Fracture type	Anterior wall	0
	Anterior column	9 (19.6)
	Posterior wall	7 (15.2)
	Posterior column	2 (4.3)
	Transverse	2 (4.3)
	Anterior column with posterior hemi transverse	8 (17.4)
	Posterior column with posterior wall	2 (4.3)
	Transverse with posterior wall	1 (2.2)
	T-shaped	5 (10.9)
	Both columns	10 (21.7)

Values are presented as mean±standard deviation or number (%).

2. Outcome Data

The scores of hip function of patients after an isolated traumatic acetabular fracture at different follow-up intervals are shown in Fig. 1. The mean score for hip function was 10.00 (95% CI 7.09-12.91) at six-week follow-up, 13.75 (95% CI 10.74-16.76 at 12-week follow-up, 16.00 (95% CI 13.40-18.60) at six-month follow-up, and 15.50 (95% CI 10.55-20.45) at one-year follow-up. The scores reflect an excellent outcome in 11 patients (64.7%), good in five patients (29.4%), and poor in one patient (5.9%) after one-year follow-up.

The course of pain at different follow-up intervals is shown in Fig. 2A. The mean score for pain was 3.00 (95% CI 1.70-4.30) at six-week follow-up, 4.50 (95% CI 3.58-5.42) at

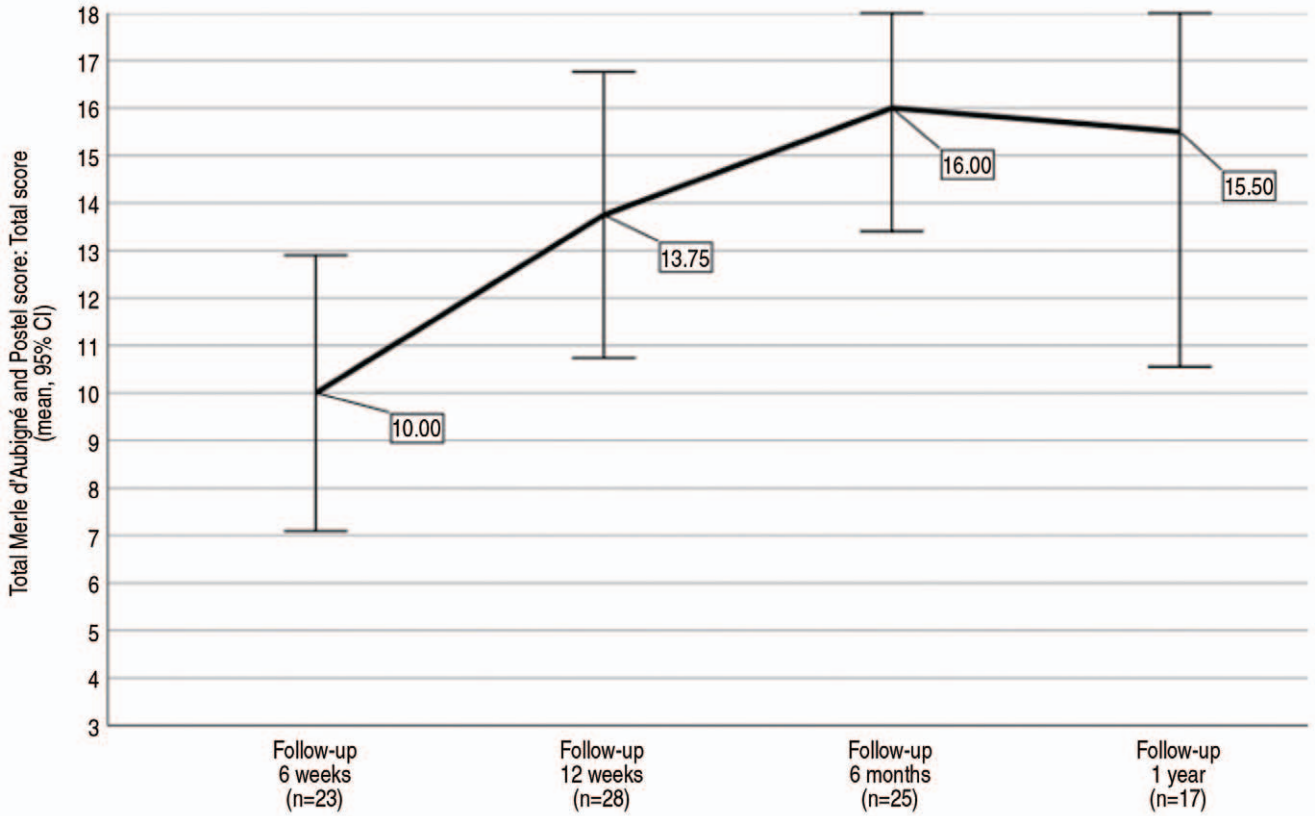

Fig. 1. Course of hip function after surgical treatment of isolated traumatic acetabular fractures.
CI: confidence interval.

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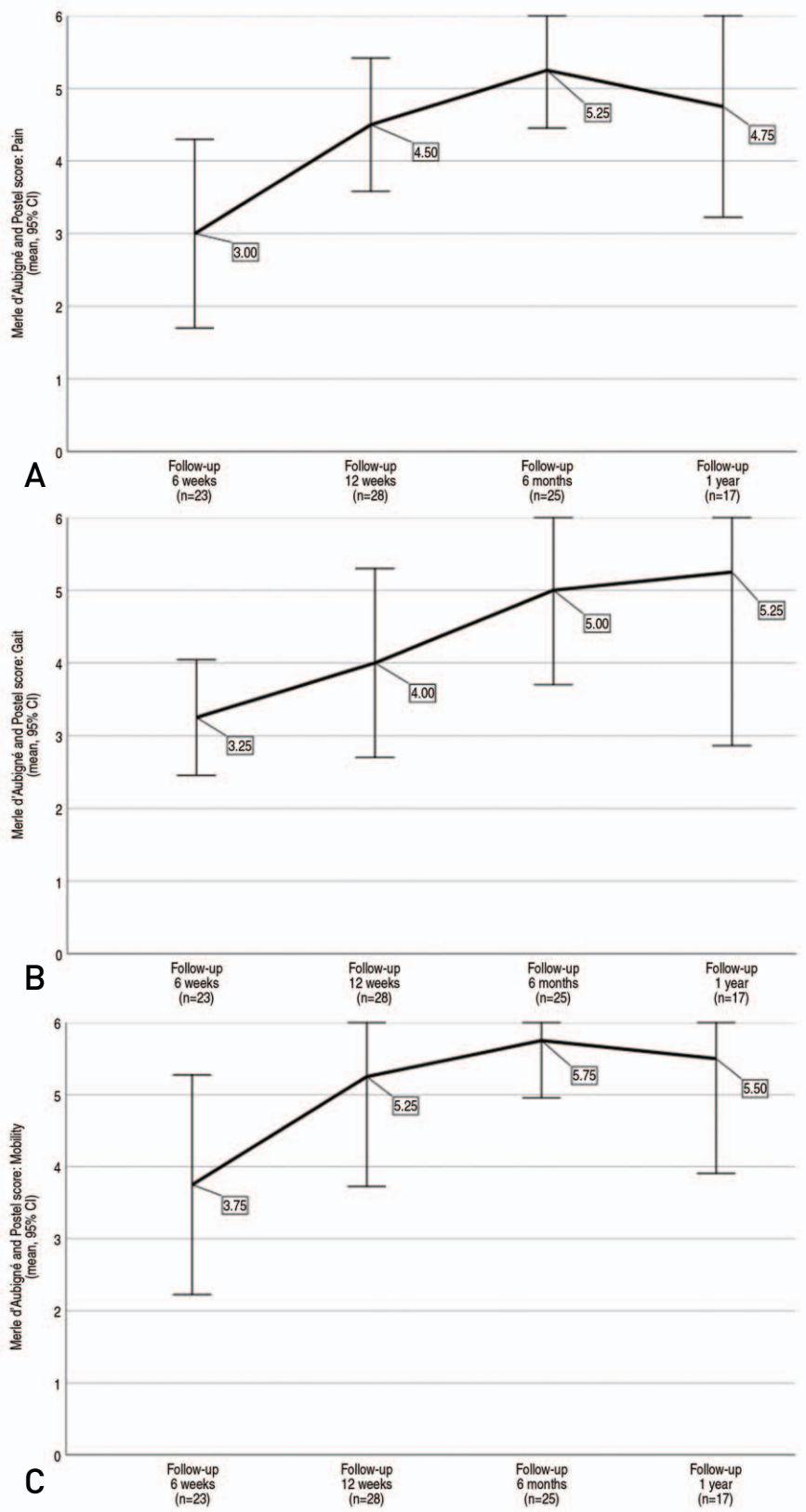

Fig. 2. (**A**) Course of pain after surgical treatment of traumatic acetabular fractures. (**B**) Course of gait after surgical treatment of traumatic acetabular fractures. (**C**) Course of mobility after surgical treatment of traumatic acetabular fractures. CI: confidence interval.

12-week follow-up, 5.25 (95% CI 4.45-6.05) at six-month follow-up, and 4.75 (95% CI 3.23-6.27) at one-year follow-up. The course of gait at different follow-up intervals is shown in Fig. 2B. The mean score for gait was 3.25 (95% CI 2.45-4.05) at six-week follow-up, 4.00 (95% CI 2.70-5.30) at 12-week follow-up, 5.00 (95% CI 3.70-6.30) at six-month follow-up, and 5.25 (95% CI 2.86-7.64) at one-year follow-up. The course of mobility at different follow-up intervals is shown in Fig. 2C. The mean score for mobility was 3.75 (95% CI 2.23-5.27) at six-week follow-up, 5.25 (95% CI 3.73-6.77) at 12-week follow-up, 5.75 (95% CI 4.95-6.55) at six-month follow-up, and 5.50 (95% CI 3.91-7.09) at one-year follow-up.

3. Missing Data

Missing data was a result of non-completed questionnaires or patients' absence at follow-up appointments. The mean outcomes of the primary analyses (available data) versus outcomes of the sensitivity analysis (available data and multiple imputed data) are shown in Table 2. The course of hip function after surgical treatment of isolated traumatic acetabular fractures after multiple imputation of missing data (sensitivity analysis) is shown in Fig. 3. The mean score for hip function was 10.00 (95% CI 7.09-12.91) in the primary analysis versus 12.07 (95% CI 11.22-12.91) in the sensitivity analysis at six-week follow-up, 13.75 (95% CI 10.74-

Table 2. Outcomes of the Primary Analysis versus Outcomes of the Sensitivity Analysis

Merle d'Aubigné and Postel score	Primary analysis (n=17)	Sensitivity analysis (n=46)
6 weeks	10.00 (7.09-12.91)	12.07 (11.22-12.91)
12 weeks	13.75 (10.74-16.76)	15.13 (14.47-15.79)
6 months	16.00 (13.40-18.60)	16.35 (15.75-16.95)
1 year	15.50 (10.55-20.45)	16.65 (16.14-17.16)

Values are presented as mean (95% confidence interval).

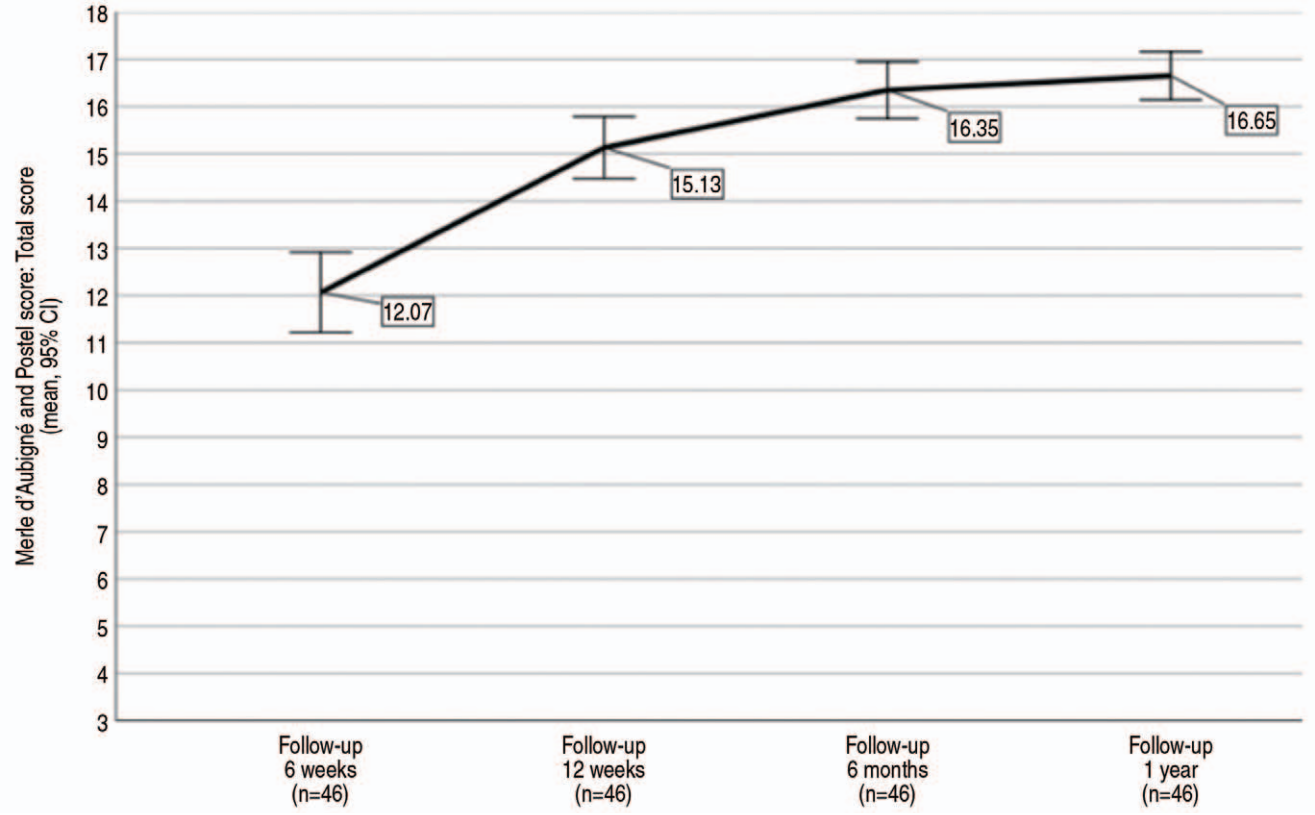

Fig. 3. Course of hip function after surgical treatment of isolated traumatic acetabular fractures: sensitivity analysis. CI: confidence interval.

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16.76) versus 15.13 (95% CI 14.47-15.79) at 12-week follow-up, 16.00 (95% CI 13.40-18.60) versus 16.35 (95% CI 15.75-16.95) at six-month follow-up, and 15.50 (95% CI 10.55-20.45) versus 16.65 (95% CI 16.14-17.16) at one-year follow-up. The mean outcomes and 95% CIs of the primary and sensitivity analysis appear to overlap, strengthening the confidence in outcomes of the primary analysis. The course of hip function after surgical treatment of elementary versus associated acetabular fractures after multiple imputation of missing data is shown in Fig. 4. The mean score for hip function was 12.25 (95% CI 10.91-13.59) for elementary fractures versus a mean score of 11.92 (95% CI 10.75-13.09) for associated fractures at six-week follow-up, 15.25 (95% CI 14.07-16.43) versus 15.04 (95% CI 14.24-15.83) at 12-week follow-up, 16.45 (95% CI 15.52-17.38) versus 16.27 (95% CI 15.43-17.11) at six-month follow-up, and 17.00 (95% CI 16.27-17.73) versus 16.38 (95% CI 15.65-17.12) at one-year follow-up. The mean outcomes and 95% CIs of elementary fractures versus associated fractures were similar, with a non-relevant lower mean total hip function at one year for the group with associated fractures. The course of hip function for age 0-59 versus ≥60 after surgical treatment of acetabular fractures and after multiple imputation of missing data is shown in Fig. 5. The mean score for hip function was 11.97 (95% CI 10.86-13.07) for age 0-59 versus 12.25 (95% CI 10.80-13.70) for age ≥60 at six-week follow-up, 15.23 (95% CI 14.44-16.02) versus 14.94 (95% CI 13.64-16.24) at 12-week follow-up, 16.90 (95% CI 16.33-17.47) versus 15.31 (95% CI 14.01-16.61) at six-month follow-up, and 16.97 (95% CI 16.45-17.48) versus 16.06 (95% CI 14.92-17.20) at one-year follow-up. The mean outcomes and 95% CIs for age 0-59 and age ≥60 were similar at six and 12-week follow-up. However, the results of the sensitivity analysis showed a mean difference of 1.59 at six-month follow-up and a mean difference of 0.91 at one-year follow-up.

DISCUSSION

This is the first prospective series that examines the course of hip function in patients after surgical treatment of isolated acetabular fractures from six-week follow-up up to one-year follow-up. Evaluation of hip function was performed using the Modified Merle d'Aubigné and Postel score. The

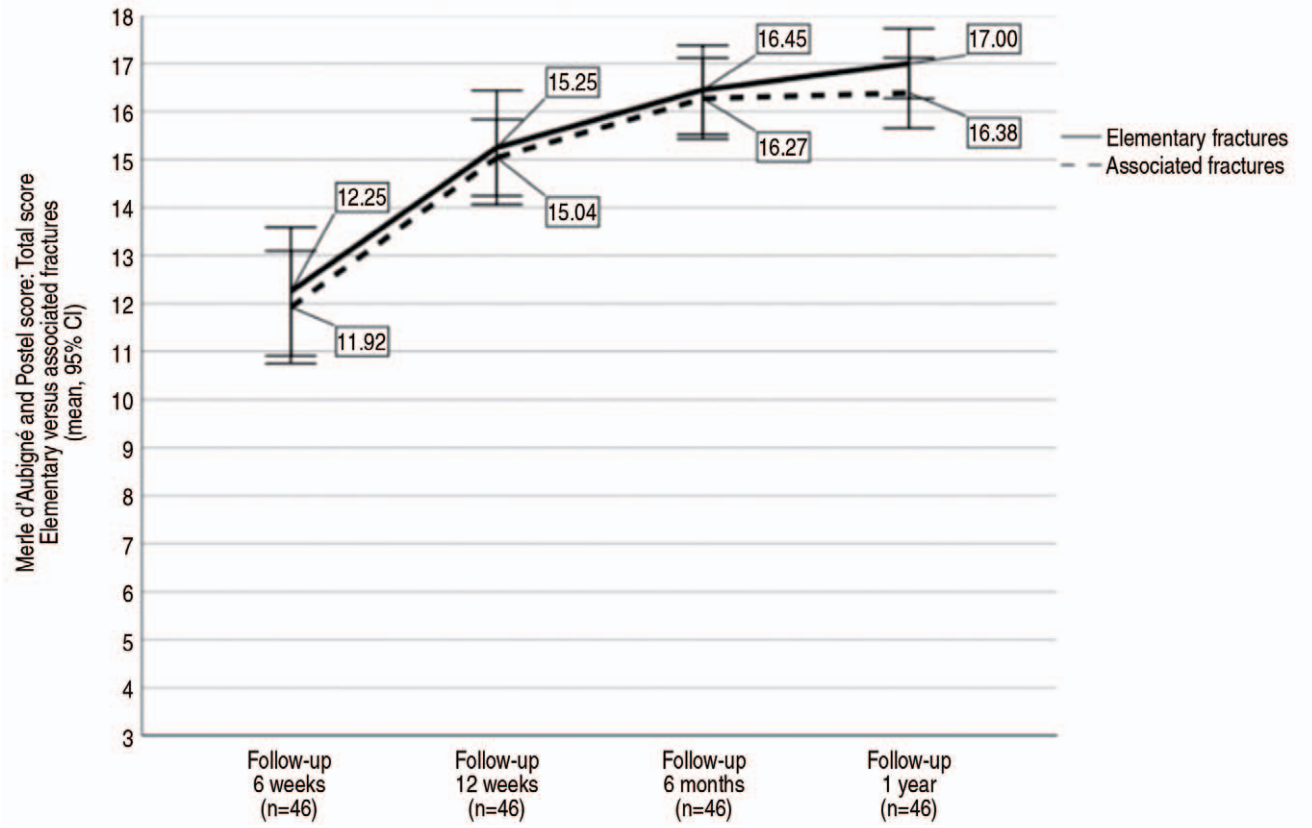

Fig. 4. Course of hip function after surgically treated elementary versus associated acetabular fractures.
CI: confidence interval.

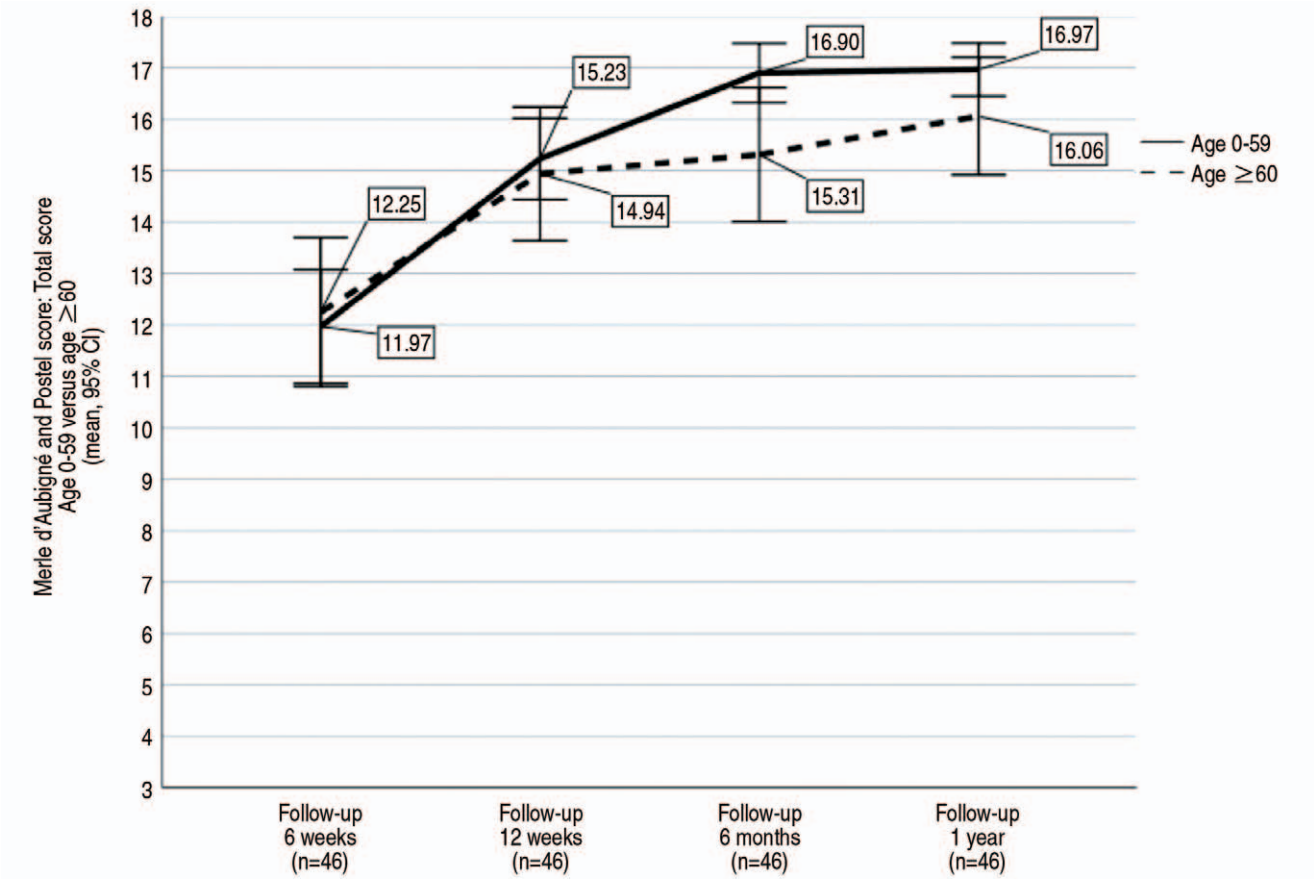

Fig. 5. Course of hip function after surgically treated acetabular fractures specified by age 0-59 versus age ≥60.
CI: confidence interval.

mean score for hip function was 10 (poor) after six weeks and 15.5 (good) after one year. These findings correspond to the hip function of young patients with an acetabular fracture with mean scores of 16 (good)[12] and 16.8 (good)[8]. After six months, patients already demonstrated good to excellent hip function with a mean score of 16. During the first six weeks, patients are only allowed to perform toe touch weight bearing using their affected leg. Progression to full weight bearing is allowed after six weeks. This is in accordance with the Arbeitsgemeinschaft für Osteosynthesefragen (AO) principles of fracture management[13]. Thus, an even faster recovery is not expected. Surprisingly, a slight decrease in total hip function resulting from increased pain and impaired mobility was observed between six-month and one-year follow-up. However, gait pattern showed continuous improvement. It may be that patients who are faring well might not return for follow-up, while patients who are still experiencing symptoms or discomfort may return for follow-up.

The results of this study might support management of expectations regarding patients' recovery. Discussion of how patients will recover after surgical treatment of an isolated acetabular fracture is difficult for surgeons and other healthcare professionals. Currently there is no standardized protocol for postoperative rehabilitation following acetabular fractures. Discussions between healthcare professionals and patients regarding the potential progression of their recovery can be conducted using data from this study. We recommended emphasizing the fact that hip function will improve during the first six months, which may be followed by a slight decrease. The most significant improvement in hip function can be expected in the first six months after surgery. A physiotherapist might play an important role in early recovery by providing exercise therapy and lifestyle recommendations[14]. In addition, the data from this study might be used by healthcare professionals in determining abnormal recovery. In cases where patients are not able to recover hip function in the first 12 weeks, an evaluation to determine possible reasons for delayed recovery might be necessary.

Nerve injury is a frequent concomitant injury in addition

to the acetabular fracture; it can also occur as a complication of surgery for treatment of an acetabular fracture. Rates ranging from 2% to 26% depending on the surgical technique have been reported[15]. In the current prospective series, a post-surgical sciatic nerve neurapraxia without clinical symptoms was detected in one patient (2.2%) one year after surgery. Heterotopic ossification, another type of high-risk injury, is an ectopic formation of bone in soft tissues which can cause pain, reduced range of motion, and impaired quality of life[16]. Incidence of heterotopic ossification after surgical treatment of acetabular fractures ranging from 7% to 100% has been reported[17]. In the current prospective series, Brooker 3 classification of heterotopic ossification without clinical symptoms was detected in one patient (2.2%) one year after surgery. Post-traumatic arthritis of the hip after acetabular fracture has been reported in approximately 13% to 44% of patients who underwent surgical treatment[8]. In the current prospective series, seven patients (15.2%) were suffering from post-traumatic arthritis of the hip one year after surgery.

These results will be useful in determining a normal or abnormal course after surgical treatment of an acetabular fracture. In addition, they might also be helpful in the effort to inform patients about the expected course. This study had some limitations. The small number of completed questionnaires is a significant limitation, limiting the accuracy of estimated mean hip function and CIs and there is also a potential for attrition bias. A sensitivity analysis was performed after multiple imputation of missing data in order to examine the influence of missing data. Findings from the primary and sensitivity analysis appear to overlap, strengthening the confidence in outcomes of the primary analysis. In a subgroup analysis of patients with elementary fractures versus associated fractures, no relevant differences in total hip function were observed between groups. In addition, no in-depth analysis for determination of factors influencing functional outcomes such as radiological evaluations (quality of reduction) after surgical treatment of isolated traumatic acetabular fractures was performed. This is an important point that should be considered in conduct of additional research.

CONCLUSION

An average of six months is required for achievement of good to excellent hip function after an isolated traumatic acetabular fracture. This information can be utilized by healthcare professionals in the effort to better inform patients regarding their (expected) recovery and in determining abnormal courses in recovery.

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CONFLICT OF INTEREST

The authors declare that there is no potential conflict of interest relevant to this article.

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