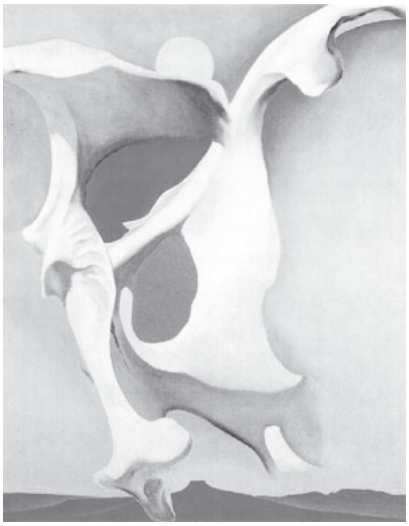
Chapter Three

Functional Outcome of Internal Fixation for Pelvic Ring Fractures

E.W. van den Bosch
R. van der Kleyn
M. Hogervorst
A.B. van Vugt

Journal of Trauma, 1999;47:365-371



SUMMARY

Objective.

Evaluation of the functional outcome after unstable pelvic ring fractures stabilized with internal fixation.

Methods.

Between January 1, 1990 and September 1, 1997 37 patients were treated with internal fixation for unstable pelvic fracture. Demographic data, type of accident, HTI-ISS and fracture type according to Tile-classification were scored. One patient died the day after the accident from neurological injury. A Short Form-36 health questionnaire and a form regarding functional result after pelvic trauma, adapted from Majeed et al., were returned by 31 out of 36 patients (86%). 28 Patients (78%) were seen for physical and radiological examination.

Results.

26 Men and 11 women, with an average age of 34.7 (range 15-66) were included. The mean ISS reached 30.4 (16-66). According to the Tile classification there were 16 type B fractures and 21 type C. 7 Patients were treated with open reduction and internal fixation (ORIF) of the pubic arch, 10 patients were treated with a combination of anterior ORIF with additional external fixation to increase the stability of the posterior ring. 19 Patients underwent internal fixation of both anterior and posterior arch. In the remaining case percutaneous posterior screw fixation was combined with anterior external fixation, because of estimated infectious risk.

The average follow-up time was 35.6 months. Patients scored 78.6 out of 100 on the Majeed score. Remarkable was the reported chance in sexual intercourse in 12 patients (40%). Only 12 patients (40%) did not have complaints when sitting. On the SF-36 scales physical and social functioning, role limitations due to physical problems and vitality were limited compared with the averages for the Dutch population. Patients treated with combined anterior and posterior internal fixation scored significantly better on both Majeed score and on the categories physical functioning, pain, general health and social functioning compared to patients with similar fractures treated with a combination of anterior internal fixation with external fixation. At the physical examination 11, out of 28, patients (39%) did not have any abnormality. 19 Patients (68%) were back at their original job, which was physically demanding in 9 cases. There was a suspicion of nonunion of the posterior arch in 2 patients, which could be confirmed with C.T. scan.

Conclusion.

In general, limitations in functioning are reported, even after long term follow-up. In partially unstable fractures solitary anterior fixation gives good results. In completely unstable fractures patients treated with combined internal fixation anterior as well as posterior scored a better outcome compared to combined internal and external fixation. Therefore, this technique is recommended as treatment of first choice in completely unstable fractures.

INTRODUCTION

Pelvic fractures are uncommon injuries, occurring in 3-8.2% of all trauma patients[1]. Of all pelvic fractures 46% is unstable according to Tile[2]. Unstable fractures are the result of high-energetic trauma and occur almost only in severely injured patients. Only very recently the evaluation of pelvic ring fractures and its management moved from radiological and early clinical results to functional results and quality of life related issues.

Pohleman et al. devised his own functional outcome score, measuring radiological results, clinical results and social reintegration on a 3 or 4 point scale. After an average follow-up of 28 months they reported that 79% of Tile-B type lesions had excellent or good result and only 27% of Tile-C type lesions had excellent or good result although 50% of the patients healed anatomically[1].

In this study we evaluated the quality of life and functional status of patients treated with internal fixation after unstable pelvic ring fractures with two different outcome scores. The Short Form-36 medical outcome score is composed of 36 questions, divided into 8 categories. Oliver et al. were the first to use the SF-36 for the outcome of pelvic fractures[3]. They followed 55 patients from the accident up to an average follow-up time of 2 years and reported 14% impairment in physical outcome score as well as 5.5% impairment in mental outcome score compared with the normal U.S. population. McCarthy et al. evaluated the outcome of 123 women with pelvic ring injuries with the SF-36 form[4]. They scored significantly lower on all SF-36 scales except mental health. Miranda et al. examined 80 patients with both stable and unstable fractures, classified according to Tile classification[5]. Only physical functioning in Tile A fractures and physical functioning and bodily pain in Tile-C fractures were more than 2 standard deviations from the American population data. No difference in outcome was seen between A and B/C type fractures. Cole et al. used the SF-36 outcome score to compare it with his own outcome score in 51 patients with completely unstable pelvic ring fractures treated with internal fixation[6]. Although they do not compare his data with general data for U.S. population there is a large difference between them except in the mental health score. The disadvantage of the scoring system that they propose, is that it does not include sexual functioning, which is an aspect that is often reduced[4,5]. This is the reason why we did not use his scoring system.

The second outcome score we used is a functional grading scale devised by Majeed et al., which is divided into 7 items[7]. Each item tries to determine the functional status about a certain aspect of life. Pain, work, sitting, sexual intercourse and standing, the latter is divided into the use of walking aids, the gait unaided and the walking distance. They each score a number of points, which make up the total score, ranging from 0-100 with 100 as most favourable outcome. The advantage of the Majeed outcome score could be that it is shorter and therefore can be used more practically in a clinical setting. It also includes sitting which is a quality often limited after pelvic injuries[8].

Majeed et al. used his outcome score to evaluate the result of external fixation for unstable pelvic fracture in 42 patients[9]. They concluded that the functional result, measured by his outcome scale, was better than the anatomical results, measured by criteria adjusted from Slätis and Karaharju[10]. Functional results improved the first 18 months and were stable thereafter.

Patients and Methods

Between 1 January 1990 and 1 September 1997 the department of traumatology of the Leiden University Medical Center reviewed 38 patients with unstable pelvic ring fractures treated by internal fixation techniques. Type of injury, degree of shock, HTI-ISS and type of operation were scored from patient's charts. The fractures were classified according to the Tile classification.

All patients but one patient were treated with internal fixation of the pubic arch, in several cases combined with external or internal fixation of the sacrum/sacroiliac joint. Most patients with symphysis disruption or fractures of the superior rami close to the symphysis were treated with AO DC-plate(s). More lateral fractures of the pubic bone were treated either with AO-reconstruction plate or transpubic screws. Because of a urethra disruption with a high risk of infection, one patient was treated with internal fixation of the posterior arch combined with external fixation of the pubic bone.

When treated by internal fixation fractures of the sacrum and ilium and sacroiliac disruptions were stabilized with canulated titanium screws (Biomet®) after either open or closed reduction. Ten patients were treated with anterior internal fixation combined with external fixation of the posterior arch, using an anterior external frame applying compression posteriorly by indirect means, in six patients for type B fractures and in four patients for type C fractures. Seven Patients, all but one with type B fractures, did not require stabilization of the posterior ring.

The patients were sent a questionnaire based on the items of the functional score of Majeed and the Dutch translation of the MOS SF-36. They were also invited for physical examination and radiological follow-up with anterior-posterior, inlet/outlet views of the pelvis.

Majeed has devised a functional outcome measure for pelvic ring injuries[7]. It consists of seven questions, each with four to six answers possible, see table 1. The categories are pain, work, sitting, sexual intercourse and standing, which is subdivided into the use of walking aids, gait unaided and walking distance. Not all items have the same impact, especially pain and work have a higher impact. The questions are transposed to a 0-100 range, similar to the SF-36 score. Although not validated for the general population, it combines both the ability to function of the whole patient as specific local findings, using objective findings. One patient refused to answer the question about sexual intercourse.

The translation of the SF-36 has been validated for the Dutch population in a group of 1063 persons, with Cronbach's alpha and test-retest correlations similar to the original[11-13]. The SF-36 is divided into eight categories: physical functioning (performing activities of daily life, ten questions), social functioning (whether physical problems influenced social activities, two questions), physical and emotional role

Questions & possible answers	Points	Questions & possible answers	Points
Pain		**Standing: Walking aids**	
Intense, continuous at rest	0-5	Bedridden or almost	0-2
Intense with activity	10	Wheelchair	4
Tolerable, but limits activity	15	Two crutches	6
With moderate activity, abolished at rest	20	Two sticks	8
Mild, intermittent, normal activity	25	One stick	10
Slight, occasional or no pain	30	No sticks	12
Work		**Gait unaided**	
No regular work	0-4	Cannot walk or almost	0-2
Light work	8	Shuffling small steps	4
Change of job	12	Gross limp	6
Same job, reduced performance	16	Moderate limp	8
Same job, same performance	20	Slight Limp	10
		Normal	12
Sitting		**Walking Distance**	
Painful	0-4	Bedridden or few meters	0-2
Painful if prolonged or awkward	6	Very limited time and distance	4
Uncomfortable	8	Limited with sticks, difficult without, prolonged standing possible	6
Free	10	One hour with a stick, limited without	8
		One hour without sticks, slight pain or limp	10
Sexual intercourse		Normal for age and general condition	12
Painful (or if man erection not possible)	0-1		
Painful if prolonged or awkward	2		
Uncomfortable, different to before	3		
No complaints	4		

Table 1. Functional scoring system adapted from Majeed

(whether either emotional or physical problems influenced work, four and three questions respectively), mental health (questions about mental well-being , five items), vitality (whether patients were energetic, tired or had a zest for living, four items), bodily pain (both amount of pain and limitations due to pain are scored in two questions), general health perception (five questions about their opinion on their health in general and expectations about it). Finally changes in health (compared to 1 year ago) is an item, which is not included in any of the scores. The 36 questions in the SF-36 are transposed to scores reaching from 0-100, 0 is the least favorable outcome, 100 is the most favorable. Data entries missing were averaged, if possible, by the method described by Ware[14].

During the physical examination muscle strength, sensibility, reflexes, walking pattern and difference in leg length were tested and scored into three categories: normal (no abnormalities), abnormal but not invalidating (only slight change in walking pattern without limitations, muscle strength less than two muscle groups with 4 out of 5 or sensibility of minor without loss of essential parts) and invalidating (severe change in walking pattern or regular use of canes/crutches/wheelchair, muscle strength two or more muscle groups strength 4 or less, loss of protective sensibility).

Data was analyzed using student-t test, chi-square for small groups and correlation-regression.

RESULTS

During this period 37 patients, 26 men and 11 women, with an average age of 35.1 years (range 15-66 years) were treated with internal fixation of the pelvic ring. 23 patients sustained a motor vehicle accident, 9 patients fell from height and 5 patients had a crush injury. Of all patients 21 were directly transferred to the Leiden University Medical Center and 16 were referred by other hospitals. 20 Patients had a degree 1 shock according to the ATLS®, 9 patients degree 2, 6 patients degree 3, and 1 degree 4 shock, once the circulatory status could not be classified clearly. The average ISS was 30,4 ranging from 16 to 66.

Data about additional systemic or loco-regional injuries are presented in table 2. The Tile classification is shown in table 3. The various combinations of internal and external fixation are shown in table 4. Of the 20 patients treated with posterior internal fixation 5 were bilateral. One patient was declared brain dead due to massive neurological damage after surgery. There were 13 complications, 3 patients developed an ARDS, 3 patients received treatment for an ileus, 4 patients had a pulmonary atelectasis or pneumonia and there were 3 other complications. After an average of 32.0 days admission to the hospital the patients were dismissed.

10 patients were re-operated after an average time of 9.3 months (range 0-24). In 5 patients osteosynthesis material was removed because of complaints of pain, in 2 patients infection made it necessary to remove the osteosynthesis material, 2 patients had a nonunion which required reoperation and in one patient the lagscrew in the pubic bone had to be removed because it had penetrated the acetabulum.

Systemic injury	Patients	(%)	Loco-regional	Patients	(%)
Circulatory shock, degree 3 / 4	7	(19%)	Open fracture	4	(11%)
Neurological or Head/neck	15	(41%)	Urological	6	(16%)
Thorax	8	(22%)	Ano-rectal	2	(5%)
Abdomen	9	(24%)	Nerve	8	(22%)
Spine	5	(14%)	Vascular	4	(11%)
Upper extremity	13	(35%)			
Lower extremity	15	(41%)			

Table 2. Additional systemic and loco-regional injuries sustained by patients

After an average follow-up time of 35.6 months (range 4-84 months) 31 patients (86%) returned both Majeed outcome score and SF-36 questionnaire. 5 patients were lost to follow-up for various reasons. One patient has been admitted to a psychiatric hospital, one patient remained in coma following the accident, two patients moved abroad and one patient did not return the forms. Of the 31 patients three refused physical examination or did not show up at the time of visit.

The results of the SF-36 questionnaire compared with average scores for the Dutch population are shown in Figure 1. Except emotional role and mental health the differences between our patients and the Dutch population are significant ($p<0.05$).

Type	Description	Patients	(%)
B1	Incomplete disruption posterior arch unilateral “open book”	3	(8%)
B2	Incomplete disruption posterior arch unilateral internal rotation, lateral compression	6	(16%)
B3	Incomplete disruption posterior arch bilateral	7	(19%)
C1	Complete disruption posterior arch unilateral	17	(46%)
C2	Complete disruption posterior arch unilateral, incomplete contralateral	1	(3%)
C3	Complete disruption posterior arch bilaterally	3	(8%)

Table 3. Fracture classification according to Tile

	Internal fixation anterior	External fixation anterior
Internal fixation posterior	19	1
External fixation posterior	10	0
No fixation posterior	7	0

Table 4. Combinations of fixation techniques of the anterior and posterior arch. (n=37)

On the outcome scale of Majeed 12 patients (40%) reported a change in sexual intercourse. Sitting was clearly limited with only 12 patients (39%) being able to sit without complaints. 24 patients (77%) did not use any walking aids and 24 patients (77%) reported a slight or no change in walking pattern. The correlations between pain on SF-36 scale and Majeed scale (r=0.79) and between the sum of the categories sitting and the 3 walking categories on the Majeed score and physical functioning on the SF-36 was very high (r=0.79).

There was no difference between patients treated with combined anterior and posterior internal fixation and patients treated with limited anterior fixation in Majeed or SF-36 scores, but patients treated with limited anterior fixation had a significantly higher percentage of partially unstable type B fractures (17% vs. 86%), in which a better outcome could be expected[1]. See Figure 2.

	Walking pattern	Strength	Sensibility
Normal	17 (61%)	22 (79%)	20 (71%)
Abnormal but not invalidating	4 (14%)	2 (7%)	6 (21%)
Invalidating	7 (25%)	4 (14%)	2 (7%)

Table 5. Results of physical examination

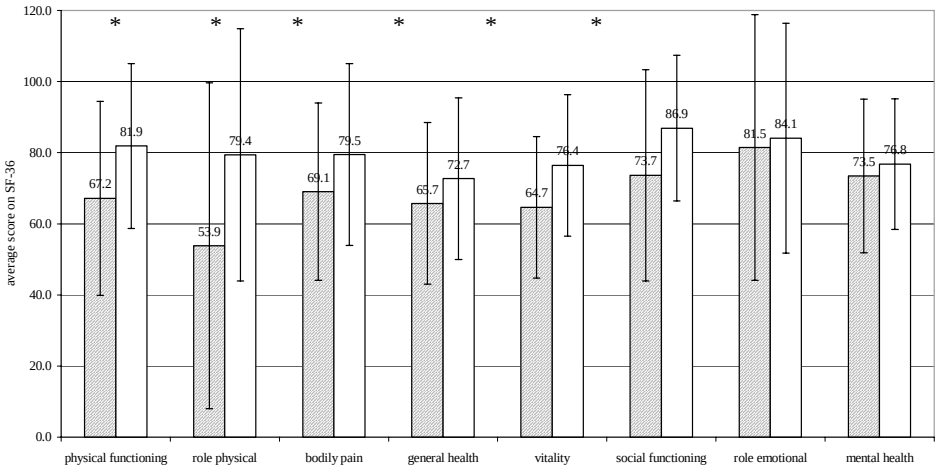


Figure 1. Outcome scores for pelvic fractures versus Dutch population. Shaded bars: patients (n=31). Open bars: Dutch population. Asteriks: significant differences ($p<0.05$)

There was a significant difference in outcome between patients treated with internal fixation of both anterior and posterior arch and those treated with additional external fixation. The results are shown in Figure 2. There was no significant difference between these groups in average age, ISS, loco-regional or systemic injury, the follow-up time for patients treated with combined external fixation was even significantly longer than for patients treated with internal fixation.

There was a significant difference on the general health scale in the SF-36 between patients with follow-up time shorter than 12 months and those with follow-up time longer than 12 months.

The results of the findings at the physical examination are shown in table 5. 11 Patients did not have any abnormalities at physical examination nor complaints about urination/defecation or work. When asked about their work, 2 patients reported to be unable to work and 6 patients had to change jobs because of their injuries. 19 patients were able to work as before and 9 of them had physically demanding work. 21 patients had no urological complaints, 3 reported increased frequency, 2 had stress incontinence, and one had a urostomy. One patient had a colostomy and one patient had a sphincter reconstruction by gracilis transposition[15], the other 25 had no complaints about defecation.

The difference in leg length was measured clinically, 20 patients had less than 10 mm difference, 5 patients had a difference between 10-20 mm and 2 patients had a difference larger than 20 mm. 31 patients had recently been examined radiologically. 22 patients had no difference in leg length, 6 patients had a difference between 10-20 mm and in 3 patients the difference was larger than 20 mm. There was no relationship between difference in leg length and outcome.

DISCUSSION

In this study we identified 37 patients who were treated for pelvic ring fractures with internal fixation, either of the anterior or the posterior arch or combined internal fixation. All but one patient survived and most of them were in reasonable condition and able to work. However several of them reported severe limitations resulting in decreased performance and quality of life, complaints of pain or discomfort when sitting and changes in sexual intercourse.

Pelvic ring fractures present themselves almost only in severely injured patients, most of them with several potentially life-threatening injuries, which is also reflected in this study by the high average ISS of 30.4 points. Initial stabilization and treatment is often primarily aimed at the survival of the patient and long-term outcome is, at that moment, of secondary importance. But as the advances in medicine, especially in the initial treatment of traumatized patients, develop the outcome after several years and the remaining limitations of the accident should be the main focus.

Although several parameters for the outcome of injured patients on short term have been established (ISS, haemodynamic instability and Tile classification[16,17], no study has shown a correlation between these and functional outcome on longer term.

The two scoring systems we used in this study have a different purpose. Because the SF-36 is rather complicated it is not the most suitable instrument to use as a doctor when dealing with an individual patient. Therefore we evaluated whether the scoring system of Majeed which, with only 7 questions, could be a more suitable instrument for this purpose. Although this scoring system is simple, it does include the most important aspects that can be limited after pelvic injury. The

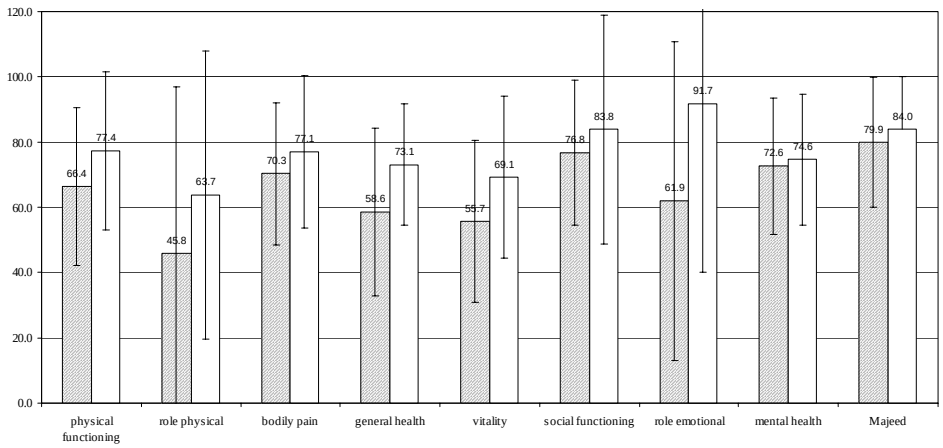


Figure 2. Technique of fixation of posterior arch versus outcome; limited anterior fixation versus internal fixation techniques. Shaded bars: limited anterior fixation (n=7). Open bars: posterior internal fixation (n=18). No significant differences.

fact that it does not include specific findings at physical examination or radiological outcomes makes it suitable as a functional outcome for an individual patient, not as an outcome based on findings at physical examination or at radiographs. It uses the patients and their limitations solely as a basis for the scoring system. When comparing the results of the scoring system of Majeed with the SF-36 the correlations between pain on either score and between sitting and standing on the Majeed score and physical functioning on the SF-36 were good. We recommend the use of the Majeed score in a clinical setting to measure the improvement of functional outcome after pelvic fracture, although it is limited to the physical aspect of life.

We chose the SF-36 as one of our measures for overall health since it has been established as a well validated and reliable outcome score for both the American and the Dutch population. It is very much suitable to chart the outcome of groups of patients and comparing these, but it is less suited for the outcome of the individual patient in a clinical setting, because it takes some time to complete and it is not easy to calculate the scores. Despite the fact that it has proven its reliability, it has potential flaws. There may be confounding factors, such as habits, socio-economical status or co-existing diseases, which, especially in small groups of patients, may influence the results. There is no validated disease-specific outcome score available for patients with pelvic ring fracture. The SF-36 does not include sexual functioning, an aspect which is clearly more often limited in patients after pelvic fracture than in the general population.

Several authors recommended internal fixation over conservative treatment or external fixation[18-20]. Matta et al reported superior results of internal fixation after a short follow-up time compared to conservative treatment and external fixation[21]. In this article there was a significant difference in outcome on both the outcome score devised by Majeed and several items of the SF-36 between patients treated with the combination of internal fixation of the anterior arch with

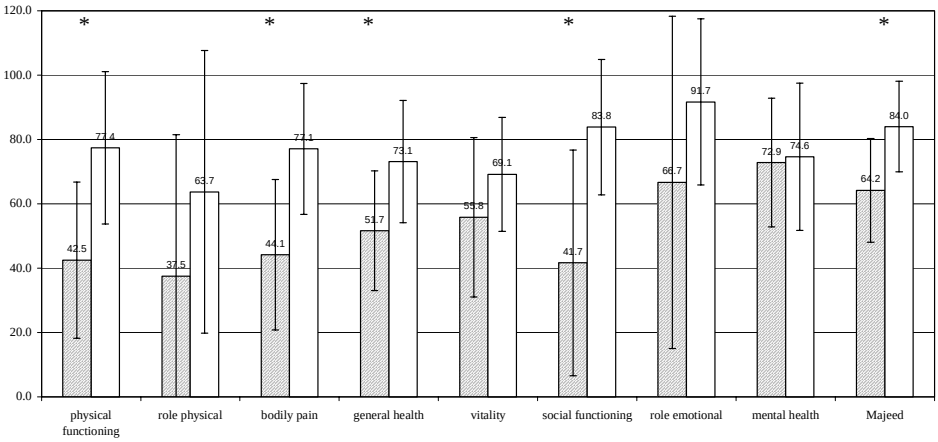


Figure 3. Technique of fixation of posterior arch versus outcome. External fixation versus internal fixation posterior arch. Shaded bars: external fixation (n=6). Open bars: internal fixation (n=18). Asteriks: denote significant differences ($p<0.05$)

external fixation of the posterior arch and internal fixation of both anterior and posterior arch. Although the number of patients we treated is small, the differences were large and except for the difference in follow-up time, which is even in favor of patients treated with combined internal and external fixation, no other confounding factors were found. If these differences can be confirmed in a larger, multi-center, study it could be an important result. In partially unstable fractures apparently satisfactory results were obtained by limited anterior internal fixation techniques. Improvement by combined anterior and posterior techniques should be a part of further investigation. The conclusion from this group of patients is that internal fixation of the posterior arch is superior the external fixation and is therefore recommended for the treatment of unstable pelvic ring fracture.

REFERENCES

1. Pohlemann T, Gansslen A, Schellwald O, Culemann U, Tscherne H. Outcome after pelvic ring injuries. *Injury*. 1996;27 Suppl 2:B31-B38.
2. Tile M. Classification. *Fractures of the Pelvis ad Acetabulum*. Media: Williams & Wikins; 1995:66-101.
3. Oliver CW, Twaddle B, Agel J, Routt ML, Jr. Outcome after pelvic ring fractures: evaluation using the medical outcomes short form SF-36. *Injury*. 1996;27:635-641.
4. McCarthy ML, MacKenzie EJ, Bosse MJ, Copeland CE, Hash CS, Burgess AR. Functional status following orthopedic trauma in young women. *J Trauma*. 1995;39:828-836.
5. Miranda MA, Riemer BL, Butterfield SL, Burke CJ, III. Pelvic ring injuries. A long term functional outcome study. *Clin Orthop*. 1996;152-159.
6. Cole JD, Blum DA, Ansel LJ. Outcome after fixation of unstable posterior pelvic ring injuries. *Clin Orthop*. 1996;160-179.
7. Majeed SA. Grading the outcome of pelvic fractures. *J Bone Joint Surg Br*. 1989;71:304-6.
8. Letournel E. [Surgical fixation of displaced pelvic fractures and dislocations of the symphysis pubis (excluding acetabular fractures) (author's transl)]. *Rev Chir Orthop Reparatrice Appar Mot*. 1981;67:771-782.
9. Majeed SA. External fixation of the injured pelvis. The functional outcome. *J Bone Joint Surg [Br]*. 1990;72:612-614.
10. Slatis P, Karaharju EO. External fixation of unstable pelvic fractures: experiences in 22 patients treated with a trapezoid compression frame. *Clin Orthop*. 1980;73-80.
11. Brazier JE, Harper R, Jones NM et al. Validating the SF-36 health survey questionnaire: new outcome measure for primary care. *BMJ*. 1992;305:160-164.
12. VanderZee, KI and Sanderman R. Het meten van de Algemene gezondheids-toestandmet de RAND-36: een handleiding. Groningen, The Netherlands. Noordelijk centrum voor Gezondheidsvraagstukken , 1-28. 1990.
13. VanderZee KI, Sanderman R, Heyink J. A comparison of two multidimensional measures of health status: the Nottingham Health Profile and the RAND 36-Item Health Survey 1.0. *Qual Life Res*. 1996;5:165-174.
14. Ware JE, Jr., Snow K, Kosinski M, Gandek B. Scoring The SF-36. *SF-36 Health Survey: Manual & Interpretation Guide*. Boston: Nimrod Press; 1993:6-22.
15. Baeten CG, Geerdes BP, Adang EM et al. Anal dynamic graciloplasty in the treatment of intractable fecal incontinence. *N Engl J Med*. 1995;332:1600-5.

16. Tile M. Pelvic ring fractures: should they be fixed? *J Bone Joint Surg Br*. 1988;70:1-12.

17. Hesp WL, van der WC, Keunen RW, Goris RJ. Unstable fractures and dislocations of the pelvic ring—results of treatment in relation to the severity of injury. *Neth J Surg*. 1985;37:148-152.

18. Ward EF, Tomasin J, Vander Griend RA. Open reduction and internal fixation of vertical shear pelvic fractures. *J Trauma*. 1987;27:291-295.

19. Bosch U, Pohlemann T, Tscherne H. [Primary management of pelvic injuries]. *Orthopade*. 1992;21:385-392.

20. Tornetta P, III, Dickson K, Matta JM. Outcome of rotationally unstable pelvic ring injuries treated operatively. *Clin Orthop*. 1996;147-151.

21. Matta JM, Saucedo T. Internal fixation of pelvic ring fractures. *Clin Orthop*. 1989;83-97.