



Clinical Consequences of Hip Instability in Acetabular Fractures with Poor Reduction Quality

Redüksiyon Kalitesi Kötü Olan Asetabulum Kırıklarında Kalça İnstabilitesi Varlığının Klinik Sonuçlara Etkisi

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ABSTRACT

Aim: The treatment of the acetabular fractures is still an important topic of orthopaedic surgery because of complex anatomy of the acetabulum and serious complications. Although the reduction quality of acetabular fractures is accepted as the most important prognostic factor, the clinical outcome is not always poor in patients with poor reduction quality. The purpose of the present study is to analyze the prognostic effects of subtle hip instability on clinical results after poor reduction of acetabular fractures.

Material and Methods: A total of 31 patients were recruited to the study with poor reduction quality after acetabular fracture surgery. The clinical outcome was assessed according to modified Merle d'Aubigné hip scoring. The patients were divided into two groups as good and poor outcome. The time interval between trauma and surgery, associated hip dislocation or pelvic injury, iatrogenic nerve injury, infection, heterotopic ossification, osteoarthritis and subtle hip instability were assessed, whether these factors affected the clinical outcome or not.

Results: Twenty-six of the 31 patients were male. The mean age was 40 years and the mean follow-up period was 64 months. The mean time interval between trauma and surgery was 7.7 days. Fourteen patients had isolated acetabular fractures while there were associated injuries in remaining 17 patients. Posttraumatic arthritis was the most common complication in this study. The clinical outcome was good in 11 of 31 patients and poor in remaining 20 patients. Subtle hip instability was found to negatively affect clinical outcome.

Conclusion: We showed that subtle hip instability would be a useful prognostic factor for the determination of reduction quality. Also, we suggested that subtle hip instability is a more objective method for assessment of reduction quality due to interobserver variability in classification according to Matta criteria.

Key words: acetabular fracture; reduction quality; subtle hip instability

ÖZET

Amaç: Asetabulum kırıklarının tedavisi; asetabulumun kompleks anatomisi ve gelişen komplikasyonlar nedeniyle halen önemini koruyan konuların başında gelmektedir. Asetabulum kırıklarında redüksiyon kalitesi en önemli prognostik faktör olarak kabul edilmesine rağmen, redüksiyon kalitesi kötü olan tüm hastalarda klinik netice kötü değildir. Çalışmamızın amacı; redüksiyon kalitesi kötü olan asetabulum kırığı hastalarında 'subtle hip instability' varlığının klinik sonuca etkisini araştırmaktır.

Gereç ve Yöntem: Redüksiyon kalitesi kötü olarak değerlendirilen 31 hasta çalışmaya alındı. Klinik değerlendirmede Merle d'Aubigné kalça değerlendirme skoru kullanıldı. Redüksiyon kalitesi kötü olan hastalar klinik sonuçlarına göre iyi ve kötü olarak iki gruba ayrıldı. Klinik sonuca etkili faktörlerden travma sonrası cerrahiye kadar geçen süre, ek pelvik patoloji varlığı, iatrojenik nörolojik hasar olması, kalça dislokasyon varlığı, cerrahi sonrası enfeksiyon gelişmesi, heterotopik ossifikasyon varlığı, osteoartroz varlığı ve erken dönem 'subtle hip instability' varlığı araştırıldı. Bu faktörlerin klinik sonuca etkileri istatistiksel olarak değerlendirildi.

Bulgular: Çalışmaya dâhil edilen 31 hastanın 26'sı erkek, beşi kadındı. Hastaların yaş ortalaması 40, ortalama takip süresi 64 aydı. Travma ile cerrahi arasında geçen süre ortalama 7,7 gündü. On dört hastada izole asetabulum kırığı mevcut iken, 17'sinde asetabulum kırığına eşlik eden yaralanmalar bulunmaktaydı. Hastalarda en sık komplikasyon posttravmatik artroz idi. Otuz bir hastanın 11'inde klinik sonuç iyi ve mükemmel, 20 hastada ise klinik sonuç orta ve kötü olarak bulundu. Erken dönem 'subtle hip instability' varlığının klinik sonucu kötü yönde etkilediği görüldü.

Sonuç: Redüksiyon kalitesinin kötü olarak belirlendiği hastalarımızda, 'subtle hip instability'nin redüksiyon kalitesi belirlenmesinde kullanılabilir bir prognostik faktör olduğu saptandı. Ayrıca Matta kriterlerine göre yapılan sınıflamada araştırmacılar arası ölçüm farkları nedeniyle 'subtle hip instability'nin daha objektif bir değerlendirme yöntemi olduğunu düşünmekteyiz.

Anahtar kelimeler: asetabulum kırığı; redüksiyon kalitesi; subtle hip instability

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Introduction

Acetabulum fractures frequently occur as a result of high-energy trauma. Due to the increasing number of traffic accidents and occupational accidents in proportion to the population, the number of acetabulum fractures is also increasing¹. The treatment of acetabulum fractures remains one of the most important issues due to the complex anatomy of the acetabulum, the difficulties in accessing the fracture site, its rarity compared to other injuries, the difficulty of surgical techniques, and the complications that may arise.¹ Complications that may occur in acetabulum fractures include infection, neurological injury, subtle hip instability, heterotopic ossification (HO), avascular necrosis (AVN), post-traumatic arthrosis, deep vein thrombosis (DVT), pulmonary embolism (PE), and mortality²⁻⁵.

The functional outcomes of patients with acetabulum fractures depend on various factors, some of which are controllable. The most important of these factors is that the goal is to achieve anatomical, stable fixation that allows for early surgical mobilization². To achieve this, the complex anatomy of the pelvis must be well understood, the diagnosis must be correctly made, and the most appropriate surgical approach must be chosen. In displaced acetabulum fractures, the main approach aims to prevent post-traumatic osteoarthritis, the most important late complication of acetabulum fractures, through anatomical reduction and rigid internal fixation⁶⁻⁹.

'Subtle hip instability' is defined as the difference in the geometric centers of the acetabulum and the femoral head. The measurement is made by evaluating the distance between the geometric rotation center of the femoral head and the geometric center of the acetabulum. Under normal conditions, both centers should be at the same point. The presence of 'subtle hip instability' increases the load on the femoral head in the hip joint, leading to the development of early post-traumatic osteoarthritis¹⁰.

Although the quality of reduction is considered the most important prognostic factor in acetabulum fractures, the clinical outcome is not poor in all patients with poor reduction quality. This study aims to investigate the effect of the presence of 'subtle hip instability' on the clinical outcome in patients with acetabulum fractures who have poor reduction quality.

Materials and Methods

Ethical Approval

This retrospective study was approved by the Kocaeli University Faculty of Medicine Clinical Research

Ethics Committee on November 4, 2014, with protocol code KOU KA EK 2014/298.

Study Design

The files of 196 patients who underwent surgical treatment for displaced acetabulum fracture at the Kocaeli University Faculty of Medicine Orthopedics and Traumatology Clinic between January 2001 and January 2012 were retrospectively reviewed. Of the 41 patients whose reduction quality was evaluated as poor according to Matta's criteria in the early postoperative radiograph and whose data were collected completely, 31 were included in the study. Exclusion criteria included femoral head injury (1 patient), neurological complications following posterior hip dislocation (2 patients), development of deep infection (2 patients), major ipsilateral lower extremity injury (1 patient), development of avascular necrosis in late follow-up (2 patients), and stage 3/stage 4 heterotopic ossification (2 patients), all of which could affect long-term clinical outcome.

The Merle d'Aubigné hip assessment score was used for clinical evaluation^{10,11}. All patients underwent triple acetabular series radiographs (AP pelvis, 45° obturator oblique, and 45° iliac oblique) as defined by Judet. In addition to these radiographs, pelvic CT scans at a 2 mm slice interval and 3D tomography reconstruction performed after 2006 were conducted. Preoperative fracture configurations were drawn on pelvic models. The Judet-Letournel classification was used to evaluate acetabulum fractures. Twelve acetabulum fractures accompanied by posterior hip dislocation (9 patients, 29.0%) were reduced closed under anesthesia in the early period. Skin traction was applied following the reduction, and the reduction was checked radiologically. The time elapsed from trauma to surgery was grouped as 0-7 days, 8-14 days, and 15-28 days. Surgical indication criteria were defined as: fracture displacement greater than 3 mm, a roof arch angle less than 45° in either anteroposterior or oblique radiograph, intact posterior wall fragment less than 50% or greater than 50% with hip joint instability, intra-articular free fragment, and marginal impaction greater than 3 mm.

All patients were started on subcutaneous low molecular weight heparin to prevent thromboembolism risk and continued until the 4th postoperative week. Patients were given antithrombotic stockings before surgery and for up to 3 months post-operatively. All patients received infection prophylaxis with 3 doses of first-generation

intravenous cephalosporin daily, starting 12 hours before surgery, repeated every 4 hours during surgery, and continuing until the 3rd day post-surgery. Ilioinguinal, Modified Henry, Kocher-Langenbeck, and combined approaches were used for surgical incisions. The combined approach involved using one of the ilioinguinal and posterior approaches together.

In the early postoperative period, serial acetabular radiographs were taken to evaluate the quality of reduction and fixation, and joint surface displacement was measured in millimeters and evaluated according to Matta's criteria^{12,13}. Accordingly, 0–1 mm fracture displacement was considered anatomical reduction, 1–3 mm displacement was considered adequate reduction, and 3 mm and above displacement was considered poor reduction.

In early postoperative radiographs, the presence of 'subtle hip instability' was evaluated based on the geometric centers of the acetabulum and femoral head. Additionally, the center of hip rotation was assessed in postoperative radiographs, and the amount of change with the opposite hip joint was determined vertically and horizontally (the distance of the center of femoral head rotation from the midline and the amount of vertical change along the midline). The amount of change was measured in millimeters. Two groups were determined: those with a change of 3 mm or more, and those with a rotation center change of less than 3 mm. The effect of rotation center change on clinical outcome was evaluated. In the early postoperative period, patients underwent complete blood count, hematocrit, and biochemical examinations, as well as neuromuscular examination, to assess the presence of neurological deficits. If superficial infection was detected at the incision site, a culture was taken and empirical antibiotic treatment was initiated. To reduce the incidence of postoperative heterotopic ossification, 75 mg of indomethacin was given for 6 weeks.

In all cases, passive hip exercises, isotonic (hip flexor, abductor) and isometric strengthening exercises (hip adductor and knee extensor muscle groups) were initiated in the early postoperative period. Continuous passive motion devices were applied to all patients with limited hip joint movement. All patients were guided to walk on their tiptoes with double crutches or a walker for 6 to 12 weeks. Patients were followed up in the outpatient clinic every two weeks until the first month postoperatively, monthly between the first and third months, every three months between the third and first year, every six months between the first and second years, and annually after the second year.

Results

Of the 31 patients with poor reduction quality included in the study, 26 were male and 5 were female. The patients' ages ranged from 20 to 79 years, with an average of 40 years. The average follow-up period ranged from 64 months (2–12 years), and 17 patients had left and 14 patients had right acetabulum fractures. The etiology of the fractures included 15 in-vehicle traffic accidents (IVA), 10 out-of-vehicle traffic accidents (OVA), and 6 falls from a height (Table 1). In our study, only the patient group with poor reduction quality was evaluated, and patients were grouped according to Matta's clinical scoring system as those

Table 1. Patient characteristics and postoperative outcomes

Demographic data	Number (percent)
Age	40 (20-79)
Gender	
Female	5 (16.1%)
Male	26 (83.9%)
Side	
Right	14 (45.1%)
Left	17 (54.9%)
Postoperative complications	
Posttraumatic arthritis	26 (83.8%)
Heterotopic ossification	10 (32.2%)
Infection	2 (6.4%)
Follow-up (months)	64 (24 -144)
Etiology of fractures	
In-vehicle traffic accident	15 (48.3%)
Non-vehicle traffic accident	10 (32.2%)
Falling from a height	6 (19.3%)
Time until the operation (days)	7,7 (1- 20)
Types of incisions	
Posterior	10 (32.2%)
Ilioinguinal	10 (32.2%)
Combine	11 (35.4%)
Bleeding amount varies depending on the type of incision	(Average/cc)
Posterior	1000
Ilioinguinal	1400
Combine	2100
Surgery times according to incision types	(Average/minute)
Posterior	125
Ilioinguinal	155
Combine	305
Fracture type	
Transverse fractures	6 (19.3%)
Transverse + posterior wall fractures	7 (22.5%)
T type fractures	5 (16.1%)
Anterior column + posterior hemitransverse fractures	2 (6.4%)
Both column fractures	11 (35.4%)
Presence of other injuries	
Contralateral extremity trauma	10 (32.2%)
Hip dislocation	9 (29%)
Brain injury	2 (6.4%)
Abdominal injury	3 (9.6%)
Chest injury	2 (6.4%)
Vertebra fracture	1 (3.2%)
Additional pelvic injury	8 (25.8%)

Table 2. Evaluation of patients according to matta's clinical and radiological scoring system, considering fracture type and incision used

Fracture type	Incision	Number	Clinical evaluation				Radiological evaluation			
			Excellent	Good	Moderate	Bad	Excellent	Good	Moderate	Bad
Transverse	Posterior	3	1	1	1	-	-	1	2	-
	Combine	2	-	-	2	-	-	-	2	-
	li	1	-	-	1	-	-	-	1	-
Tr+Pw	li	3	-	-	-	3	-	-	-	3
	Posterior	4	1	-	-	3	-	1	-	3
T type	Posterior	2	2	-	-	-	-	1	1	-
	Combine	3	-	-	-	3	-	-	1	2
Ac+Ph	li	2	1	1	-	-	-	1	-	1
Both column	li	4	2	-	1	1	-	1	1	2
	Combine	6	-	1	1	4	-	-	3	3
	Posterior	1	-	1	-	-	-	-	-	1
Total	-	31	7	4	6	14	-	5	11	15

Tr+Pw: transverse+posterior wall; Ac+Ph: anterior column+posterior hemitransverse.

Table 3. Evaluation of patients according to Matta's clinical and radiological scoring system, considering fracture type and incision used

Subtle hip instability	Clinical result		Total
	Excellent/good	Moderate/bad	
Available	3	16	19
Unavailable	8	4	12
Total	11	20	31

with a good clinical outcome and those with a poor clinical outcome. Of the 31 patients with poor reduction quality who underwent long-term postoperative follow-up, 11 had good and excellent clinical outcomes. Of the 11 patients whose clinical outcomes were assessed as good and excellent, 5 had good results, and 6 had moderate to poor radiological results (Table 2).

As radiological results worsened, clinical results also worsened. A significant relationship was found between clinical and radiological results in our patients ($p=0.031$). However, a significant relationship was found between clinical results and the presence of 'subtle hip instability' ($p=0.021$) (Table 3). It was observed that the presence of early-stage 'subtle hip instability' negatively affected the clinical outcome. In our study, all 19 patients with 'subtle hip instability' had post-traumatic osteoarthritis. 5 patients without 'subtle hip instability' did not have osteoarthritis, but 7 patients had moderate to severe osteoarthritis. The relationship

between post-traumatic osteoarthritis and the presence of 'subtle hip instability' was found to be statistically significant ($p=0.005$).

Patients were categorized into two groups based on the calculation of vertical and horizontal hip rotation centers: those with changes of up to 3 mm and those with changes of 3 mm or more. Of the 11 patients with good clinical outcomes, 5 had changes of 3 mm or more, while 6 had changes of up to 3 mm. Of the 20 patients with poor clinical outcomes, 13 had changes of 3 mm or more, while 7 had changes of up to 3 mm. The amount of change in the hip rotation center did not have a statistically significant effect on clinical outcome ($p=0.449$).

When the relationship between posterior dislocation and clinical outcome was examined, no statistically significant data was found ($p=0.32$). It was observed that the presence of hip dislocation did not affect clinical outcome. However, when the time between trauma and surgery was categorized and examined as 0–7 days, 8–14 days, and 15–28 days, it was observed that the groups did not have a statistically significant effect on clinical outcomes ($p=0.56$). No significant association was found between clinical outcome and the presence of stage 1–2 heterotopic ossification in our patients ($p=0.24$). Furthermore, no significant association was found between the presence of additional pelvic pathology and the presence of early-stage 'subtle hip instability' ($p=1$).

Discussion

The rate of post-traumatic osteoarthritis is quite high in patients with poor reduction quality after acetabulum fractures. Many studies have reported the relationship between the frequency of osteoarthritis and reduction quality^{14–16}. In a meta-analysis of surgical treatment of displaced acetabulum fractures published in 2005, Giannoudis reported that the rate of osteoarthritis development after an average follow-up of 60 months (18–120) was 13.2% in cases where the reduction quality was considered successful (≤ 2 mm), and 43.5% in cases where the reduction quality was considered unsuccessful (> 2 mm)¹⁷. Matta reported a post-traumatic osteoarthritis rate of 80% in patients with poor reduction quality after 10 years of follow-up². In our patients, the post-traumatic osteoarthritis rate was found to be 83.8%. This rate is consistent with the literature but is at the upper limit. Another method that can be used to evaluate the quality of reduction is the calculation of the center of hip rotation¹⁸. Shi et al. calculated the center of hip rotation in postoperative radiographs of 127 patients and found an average displacement of 2.8 mm in the horizontal plane and 2.2 mm in the vertical plane. They stated that this change disrupted the biomechanics of the hip, which in turn increased the load on the hip joint. They reported that a 2 cm proximal and medial displacement of the center of hip rotation reduced abductor strength by 44% and flexor strength by 271%⁹. In our patients, a displacement of 3 mm or more in the center of hip rotation did not have a statistically significant effect on the clinical outcome. ‘Subtle hip instability’ is a method that objectively shows hip alignment in the postoperative period. In our study, we used the method suggested by Matta to evaluate the quality of postoperative reduction⁴. The absence of ‘subtle hip instability’ in patients with poor reduction quality was significantly evaluated as a good prognostic factor. Furthermore, we believe that ‘subtle hip instability’ is a more objective assessment method due to inter-researcher measurement differences in the classification made according to Matthew’s criteria.

In acetabulum fracture surgery, it is recommended to first ensure the patient’s stabilization and wait a certain period of time between trauma and surgery²⁰. The time elapsed from trauma to surgery is among the controllable factors. Complex type fractures should be fixed within the first 5 days. However, fixation of simple type fractures can be delayed until the 15th day²¹. A waiting period longer than 15 days will make reduction

more difficult due to the rapid formation of granulation tissue in this area²². In our study, the effect of the time elapsed between trauma and surgery on clinical outcome was not significant.

Trauma-related sciatic nerve injuries occur in 12–15% of acetabulum fractures²³. In Giannoudis’ meta-analysis of twenty articles, neurological complications were reported in 299 out of 1824 fractures (16.4%)²⁰. Only 2 of these patients had femoral complications. The rate was 40.3% in the patient group with concomitant posterior hip dislocation. Iatrogenic nerve damage was reported as an average of 8% in the same study. Helfet and Vrahas reported that iatrogenic sciatic nerve paralysis mostly develops due to prolonged traction and incorrect retraction²⁴. In our study, none of the 31 operated patients showed iatrogenic nerve damage. We attribute the absence of iatrogenic nerve damage to the modified Henry approach used in the posterior approach, which involves dissecting and preserving the sciatic nerve, working with the knee in flexion, and high surgical experience. The presence of posterior hip dislocation has been shown in many studies to be a factor affecting prognosis. Şahin et al. examined 57 patients with posterior hip fracture-dislocation and reported a good clinical outcome in 70% of cases. During follow-up, osteoarthritis developed in 10 patients (17.5%) and avascular necrosis in 5 patients. They considered the time of hip reduction as a factor affecting the clinical outcome²⁵. Moed et al. reported 85% good and excellent outcomes after 5 years of follow-up in 94 hip fracture-dislocation cases¹⁵. In our study, 9 out of 31 patients had posterior hip dislocation, and the presence of hip dislocation did not have a statistically significant effect on the clinical outcome. The rate of infection after surgical treatment of acetabulum fractures has been reported to be between 4% and 19%^{4,26}. In a meta-analytic study by Giannoudis et al., the rate was found to be 4.4% in a review of 19 studies in which the frequency of infection was recorded²⁰. The superficial infection rates observed in our study were consistent with the literature.

Heterotopic ossification (HO) occurs in varying percentages, ranging from 15% to 50% in different series, depending on various factors^{26,27}. These studies have indicated that the use of indomethacin alone or in combination with radiotherapy is effective in reducing the incidence of heterotopic ossification²⁷. However, a prospective study by Matta and Siebenrock suggested that indomethacin had no effect. Matta reported HO

in 8% of posterior KL, 20% of extensible iliofemoral, and 2% of ilioinguinal cases in series without specific prophylactic treatment²⁸. In our own cases, despite routine 6-week indomethacin prophylaxis, HO ranging from stages 1 to 2 according to the Brooker classification was observed in 10 patients. Two patients with HO that restricted hip joint movement were excluded from the study. Heterotopic ossification was most frequently observed in the group with both column and transverse+posterior wall fractures.

Limitations

Our study was limited to 31 patients because we only included patients with poor reduction quality. Therefore, post-reduction 'subtle hip instability' could not be evaluated separately for each fracture type, and statistical results could not be obtained. Hip circumference muscle strength analysis, which could affect clinical outcome, was not performed in our study. Furthermore, no assessment was made of the patients' psychosocial status. The impact of their current clinical condition on their working lives was not examined. Also, our study is retrospective. In the future, the concept of early postoperative stability in our patients after reduction will be evaluated, and its effect on prognosis will be observed prospectively.

Conclusion and Recommendations

In this study, the prognostic significance of the presence of 'subtle hip instability' was investigated by excluding factors known to negatively affect clinical outcome in acetabulum fractures. In conclusion, we believe that the absence of 'subtle hip instability' in patients with poor reduction quality can be used as a good prognostic factor. We believe that after surgical treatment of acetabulum fractures, assessing the alignment of the acetabular center and the femoral head center first provides a more objective assessment of reduction quality according to the Matta criteria and has a much higher impact on the clinical outcome.

Conflict of Interest

All authors declare that there is no conflict of interest.

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