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The importance of patient selection for the treatment of proximal humerus fractures with percutaneous technique

Proksimal humerus kırıklarında perkütan tespit için hasta seçiminin önemi

Murat KAYALAR, Tulgar TOROS, Emin BAL, Kemal OZAKSAR, Yusuf GURBUZ, Yalcin ADEMOGLU

Hand Microsurgery and Orthopaedic Traumatology Hospital

Amaç: Proksimal humerus kırıklarında perkütan tespitin endikasyonları, yöntemin dezavantajları, osteoporotik yaşlı hasta grubunda yaşanan sorunlar ve hasta seçiminin önemi değerlendirildi.

Çalışma planı: Çalışmada, proksimal humerus boyun kırığı nedeniyle perkütan tespit uygulanan 18 hasta (10 erkek, 8 kadın; ort. yaş 48; dağılım 14-89) incelendi. Bu hastaların sekizi 60 yaşın üzerindeydi. Neer sınıflamasına göre beş hastada iki parçalı, 13 hastada üç parçalı kırık vardı. Hastalara kapalı yerleştirme, perkütan kalın K-teli veya Schanz vidası ile tespit uygulandı. Ortalama 23 ay (dağılım 8-60 ay) takip sonunda hastaların omuz hareket açıklığı ve omuz grafileri değerlendirildi ve Kol Omuz ve El Sorunları Anketi (DASH-T) uygulandı.

Sonuçlar: Hastaların omuz abdüksiyonu ortalama 134º (dağılım 30º-160º), elevasyonu 118º (dağılım 30º-140º) bulundu. Hareket açıklığı, iki parçalı kırıkların hepsinde olmak üzere, 11 hastada (%61.1) tamdı. Dört hastada 60º-130º arasında, üç hastada ise 30 derecenin altında abdüksiyon kaybı izlendi. Abdüksiyon kaybı görülen hastaların hepsi 60 yaşın üzerindeydi. Fonksiyonel değerlendirmede DASH-T skoru ortalaması 18 (dağılım 0-77) bulundu. Skorun 10'un altında olduğu 14 hastada ağrı ve fonksiyonel şikayet yoktu. Skoru 10'dan yüksek olan dört hastanın hepsi 70 yaşın üzerindeydi. Çivi migrasyonu yedi hastada (%38.9) meydana geldi. Bu hastaların hepsi 60 yaş üzerindeydi. Bir hastada parsiyel protez uygulaması yapıldı. Kaynamama bir hastada (%5.6), varus/valgus yanlış kaynama dört hastada (%22.2) gözlendi. Hiçbir hastada avasküler nekroz görülmedi.

Çıkarımlar: Proksimal humerus kırıklarında perkütan tespit, iki parçalı ve iyi seçilmiş üç parçalı kırıklarda tercih edilebilir. Yaşlı hastalarda komplikasyon oranının yüksek olması nedeniyle hasta seçimi dikkatli yapılmalıdır.

Anahtar sözcükler: Yaşlılık; kemik çivisi; kemik teli; kırık tespiti, internal/yöntem; humerus kırığı/cerrahi; omuz kırığı/cerrahi.

Objectives: We evaluated the indications and disadvantages of percutaneous technique for proximal humerus fractures in relation to complications encountered in osteoporotic elderly patients and the importance of patient selection.

Methods: The study included 18 patients (10 men, 8 women; mean age 48 years; range 14 to 89 years) who underwent percutaneous fixation (closed reduction and pin fixation with K-wires or Schanz screws) for proximal humerus fractures. Eight patients were beyond 60 years of age. According to the Neer classification, five patients had two-part, 13 patients had three-part neck fractures. The patients were evaluated with range of motion of the shoulder, radiographs, and the Disability of Arm Shoulder and Hand questionnaire (DASH). The mean follow-up was 23 months (range 8 to 60 months).

Results: The mean shoulder abduction was 134º (range 30º to 160º) and the mean elevation was 118º (range 30º to 140º). Full range of motion of the shoulder was achieved in 11 patients (61.1%), including all with two-part fractures. Abduction losses of 60º to 130º and less than 30º were seen in four patients and three patients, respectively, all of whom were older than 60 years. The mean DASH score was 18 (range 0 to 77). Fourteen patients having a score of less than 10 had no pain or functional complaints. Four patients with a score of more than 10 were older than 70 years. Pin migration was observed in seven patients (38.9%), all of whom were over 60 years of age. One patient required revision with partial prosthesis. Nonunion was seen in one patient (5.6%) and malunion with a varus/valgus deformity occurred in four patients (22.2%). None of the patients developed avascular necrosis.

Conclusion: Percutaneous fixation may be preferred in the treatment of two-part and carefully-selected three-part proximal humerus fractures. Due to high complication rate, patient selection is of primary importance among elderly patients.

Key words: Aged; bone nails; bone wires; fracture fixation, internal/methods; humeral fractures/surgery; shoulder fractures/surgery.

Correspondence / *Yazışma adresi:* Dr. Murat Kayalar. Hand Microsurgery and Orthopaedic Traumatology Hospital, 1418 Sokak, No: 14, 35230 Kahramanlar, İzmir- Turkey. Phone: +90232 - 441 01 21 e-mail: elmikro2003@yahoo.com

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Nowadays, there are many studies, focusing on patient selection criteria, fracture type, bone quality and implant selection in the treatment of proximal humeral fractures. The incidence of nondisplaced proximal humerus fracture varies between 49-80%.[1,2] The rest of them are the displaced fractures requiring surgery. The most frequent type of displaced fracture has been reported as a two part neck fracture.[1] Today, as the number of the elderly patients rises, the incidence of this type of fractures increases.[3] There is still no concensus on which technique is going to be applied to the patient for the displaced fractures.

Several techniques have been used so as to preserve both vascular supply of fragments and soft tissue attachments of fracture. Many treatment modalities such as conservative treatment [4,5],open reduction with plate fixation [2,6,7],osteosuture (parachute technique)[8], intramedullary nail[9], tension bant[10] were defined. Primary hemiarthroplasty can be performed where the joint protective treatment is not possible, particularly for four part fractures, dislocations with fractures and fractures exceeding more than 40 % of head diameter.[11,12] Percutaneous fixation facilitates the protection of fracture fragments vascular supply and also avoids complications such as pseudoarthrosis and avascular necrosis.[13-17] This fixation bases on reduction of the fractures without performing large incisions. If acceptable humeral inclination restoration and tubercle reduction are achieved by closed technique under flouroscopic control, percutaneous fixation can be applied. Indications are stated as two part displaced fractures, minimal displaced three part fractures and valgus impacted four part fractures.[13-17] In our clinics, loss of fixation and need to secondary procedure were observed for the elderly and osteoporotic patients who underwent percutaneous fixation. In this study, indications of percutaneous fixation, disadvantages of the method, problems experienced in elderly patients and the importance of the patient selection were retropectively evaluated.

Patients and method

Between the years of 2000-2007, 27 patients (12 female, 15 male) with proximal humerus fracture have been admitted to our hospital. The fracture location was left side in 14 patient. The mechanism of injury was traffic accident in most of the patient (n=20). The rest was resulted from fall injury. Eigthteen of 27 patients with average age 48 (ranged 14-89) who replied the final examination call, were included in this study. Eight patients were older than 60 years of age (distribution 63-89). Fracture distribution accordings to Neer classification[18] was as follows; 5 patients had two part fractures, 13 patients had three part fractures. Associated other extremity fractures were also seen in three patient. All patients were operated within first 24 hours after injury. The reasons why the percutaneous fixation were chosen for the patients over 60 years old are as follows: the patient did not want an open surgery (n=6), did not accept prothesis replacement (n=1) and the open surgery was contraindicated due to medical comorbidities (n=1). The treatment decision was made by taking into account the number of fracture fragments and surgeon's preference in the rest of the patients. While deciding on the patient to whom percutaneous fixation would be applied to, the age of the patient, the quality of the bone, the displacement and number of the fracture fragments were taken into consideration. Percutaneous fixation is a method with an indication in two or three-part proximal humeral fractures. Computerized tomography was used so as to decide whether the fracture was suitable to the percutaneous method or not. If tubercle comminution was not too much, medial calcar was intact and the lateral displacement of the head was little, the fractures were considered convenient for this method.[19,20]

Surgical technique

The first step of surgical approach was closed reduction of fractured head under flouroscopic control. While maintaning traction on the abducted (20°-30°) arm, reduction maneuver was achieved by pushing humeral shaft toward to posteriorly in order to correct apex anterior angulation. Then reduction portals were created. The first attempt was to reduce head fragment by introducing small bone hooks or periosteal elevators through the portals. Two methods were used here (Figure 1). In one of the methods, the blunt k wires (3-4 mm) were introduced intramedullary by taking care the overdilatation of cortical bone window which shouldn't be exceed the diameter of k wires to prevent wire migration. In the second method, following the reduction of head fragment, the head was fixed by threaded Schanz screws attached to drill.

The first screw was generally placed towards anterolateral 45° superior and 30° posteriorly. The fracture was usually stabilized laterally in another plane and then in tubercular area in order to achieve multiplanary fixation. When there is medial displacement, fi-

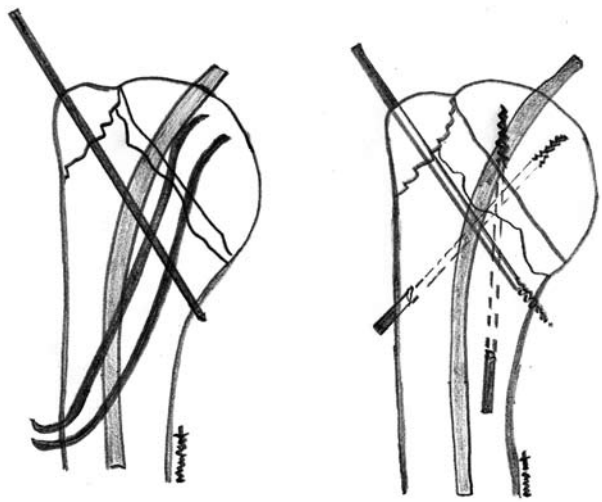

Figure 1. Methods used in percutaneous fixation: On the left, fixation of tuberculum majus and the head fragment by thick K-wires. K- wires were inserted through the window at the cortex. On the right, percutaneous fixation with Schanz screws.

xation of minus fragment is recommended. Cannulated screws were not used in our serie and tuberculum majus fixation was performed with the help of washer and spongious screw in one case. The technique gets more difficult for valgus impacted four-part fractures. Respecting to this type of fractures, after correction of inclination and version at the same time with elevation of head fragments, tubercles were reduced. Maintanance of medial periosteal bridge is very important in terms of vascularity of the head. Three wires on average were used for the patients (range 2 to 5). The period to pull out the wires was six weeks. Pins placed on tubercle superolaterally were removed earlier, at the 3rd or 4th week. All cases were closely observed for pin migration in the first 3 weeks. A sling was applied during 3 weeks postoperatively. Pendulum shoulder exercises were started on the post-operative second day. Active abduction and elevation were not allowed to prevent wire/ Schanz screw migration before 3-4th week in over sixty years old cases. Young patients were included in the high levels of physiotherapy earlier (on the15th day) in accordance with symptoms of union in the graphies. At the end of third week, active / active assistive forward elevation and abduction was permitted in those cases. At the end of follow-up, which is 23 months on average (range 8 to 60 months), the patients were evaluated with range of motion of the shoulder, frontal/ posterior axillary radiographies of the shoulder and Disability of Arm, Shoulder and Hand Questionnaire (DASH-T).[21] This questionnaire includes 30 questions concerning some physical activities and symptoms. The patients are expected to give answers between "no obstacles" and "excessive obstacles" according to the difficulties they have. The total point the patient gets at the end of the questionnaire varies between 30 (the best) and 150 (the worst). Later, this number is converted into a score of 100 with a formula and the results are determined between 0-100.

Results

For eighteen patients, shoulder abduction in the coronal plane was 134° on average (range 30° to 160°), elevation in the sagittal plane was 118° (range 30° to 140°). Full range of motion was achieved in eleven patients (61.1 %). Abduction losses of 60°- 130° and less than 30° were seen in four patients and three patients, respectively, all of whom were over 60 years of age. The range of motion was full in all two-part fractures. A significant decrease (60° 130°) in the range of motion was observed in four patients (30.8 %) with three-part fractures. Losses of range of joint motions in patients older than 60 were striking.

Functional score average was 18 (range 0 to 77) as a result of the evaluation performed with DASH-T Questionnaire. The score was below 10 in fourteen patients and these patients did not have pain or functional complaints. Four patients having a score more than 10 were older than 70. Pin migration was observed in all these patients having three-part proximal fracture. Pin migration occurred in seven patients (38.9%), all of whom were over 60 year of age. Neurovascular problems based on wire/screw migration did not occur in any patients. Termination of the treatment was needed in two patients (11.1%). One of these patients underwent hemiarthroplasty. The range of shoulder motion in this patient was limited. Partial arthroplasty was recommended to the other patient due to nonunion. However, the patient did not accept it. The problem of nonunion did not occur in any patients except this patient. Dangerous migration of wires/screws placed on tubercle towards axillary was seen in two patients. In one of the patients, Schanz screw having been placed for tuberculum majus was seen under the right breast and removed on the tenth day (Figure 2). In the other patient, unthreaded K-wire having become apparent at axilla under the skin was removed on the 15th day. Malunion was detected in four patients (22.2%) (varus deformity in one patient, valgus deformity in three patients). None of the patients developed pin tract infec-

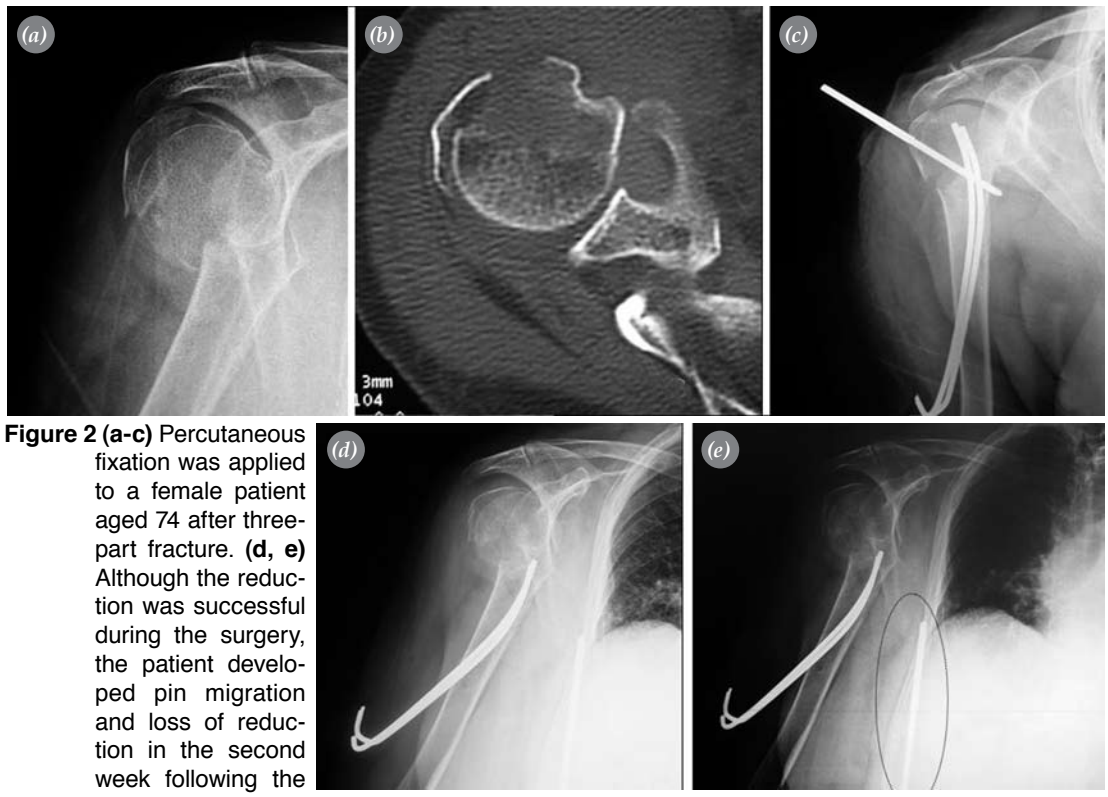

Figure 2 (a-c) Percutaneous fixation was applied to a female patient aged 74 after three-part fracture. **(d, e)** Although the reduction was successful during the surgery, the patient developed pin migration and loss of reduction in the second week following the operation.

tion and symptoms of avascular necrosis on humerus head was not detected radiographically.

Discussion

Proximal humeral fractures can result in avascular necrosis, nonunion or malunion. It has been stated that open reduction doubles the possibility of avascular necrosis.[19] When the number of fragments increases and the bone mineral density decreases, fixation of fracture becomes more difficult.[22] Gerber and his colleagues[23] emphasized the importance of anatomical reduction of the head in the joint protective surgery in terms of avascular necrosis. Avascular necrosis is seen at the rate of 12-34%, 41-59 %, 9-26% in three-part fractures, four-part fractures and valgus impacted fractures, respectively.[2-4,6,10,23-28] Percutaneous fixation has arisen so as to reduce these complications. Closed reduction and percutaneous fixation can be applied in two or three-part fractures in order to reduce the possibility of avascular necrosis. The rate of avascular necrosis in percutaneous fixation was declared between 0-21 %.[29] Jaberg and his colleagues [13], who were the first ones to present the percutaneous fixation, obtained a good result of 70 %. Resch and his colleagues [19] declared good-excellent results of 91 % in three-part fractures and 87 % in four-part fractures with percutaneous fixation. Same authors also noticed that, if there isn't any lateral displacement of head fragment in valgus impacted fractures, medial periosteal sleeve would contribute both reduction as a mainstay and vascular supply of fracture, and that percutaneous technique be preferred in non osteoporotic cases.[19] For proximal humeral fractures, alternative treatment options are plate osteosynthesis in three-part neck fractures and primary athroplasty in four-part fractures. In elderly patients, conservative treatment in four-part fractures with minimal displacement is an option in our clinic. The experience and skill of the surgeon in closed treatment is an important factor for selection of percutaneous method. The head ischemia criteria identified by Hertel and his colleagues[30] should be taken into consideration for the patient selection before the operation, which is very helpful for the success of the method. It was notified that small reduction portals could be applied after being successful at mini incisions in percutaneous fixation technique.[29] An anatomical study with regard to percutaneous fixation showed that respecting the axillary nerve branches, tubercle fixation should be done in external rotation position and that the wires/schanz screws, inserted antegradely must be

Figure 3. (a-c) Three-part proximal humeral fracture in a male patient aged 44. **(d)** After fixation of fracture, **(e)** radiographies after union and **(f)** functional condition of the patient.

capture the cortex 20 mm below on the medial side of head fragment.[16] Medial calcar of humeral shaft is an important mainstay for the fixation. It is recommended that not to vialate the periosteal bridge in that area to reduce risk of avascular necrosis.[23,30-33] Recognition of pin penetrations on the head is another important issue. Klepps and his colleagues. [34] stated that pins could be observed best when the pins placed on the anterior part of the head were moved to the arm internal rotation and the pins coming out of the posterior part of the head were moved to the arm external rotation at 60º under the scopy control. They also recommended that C-arm be rotated forward and backward at 30º so as to observe penetrations of the pin on the anterior or posterior part while getting axillary views.[34] Placing pins from tuberosite as well as multiplanary fixations, anterior, anterolateral and lateral pins increases torsional strength.[35] In this method, the surgeon must follow the patient carefully and pay attention to the pin migration or loosening. It is recommended that the loosening pins be removed due to the risk of migration. Instability and secondary displacement might occur,

Figure 4. In a female patient aged 89, after falling **(a, b)** left proximal humeral three-part fractures and left collum femoris fracture occurred. The patient to whom hip hemiarthroplasty was applied chose the conservative treatment for her left shoulder. **(c)** Left humeral valgus fracture resulted in union. **(d, e)** The patient accepted percutaneous fixation due to similar fracture having occurred on right humerus four months later. **(f)** Anatomic restoration of the humerus head is at an acceptable limit. **(g)** It is seen that the functional result on the patient's right shoulder where percutaneous fixation has been applied is better.

depending on metaphyseal defects. Soete and his colleagues [17] declared the rate of secondary displacement as 12 %. Resch and his colleagues [36] recommended open reduction for the cases having medial translation and Calvo and his colleagues[37] pointed out that as the number of the displaced parts in percutaneous fixation increases, the quality of reduction decreases. This situation causes increase in permanent deformity rate after surgery.[37] Cannulated screws were not used, which is one of the disadvantages of our study. We are of the opinion that cannulated screws facilitate particularly tuberculum majus fixation and reduce the possibility of antegrade pin migration we have experienced. While the results of young patients having two and three-part fractures were good (Figure 3), pin migration (n=7, 38%) and functional low score (n=4, 22.2%) in elderly patients were seen more often (Figure 4). Avascular necrosis was not observed and the range of motion and the rate of union were high in young patients. These are regarded as successful points of the method. For the elderly patients, when the patient does not accept primary hemiarthroplasty or open surgery is risky, it is required to make a choice between conservative treatment and minimal invasive techniques (Figure 4). The difficulties that we have experienced with elderly patients raises this question: "Would we have obtained good results if conservative treatment had been applied to these patients?"

Conservative treatment might be a good choice for the patients having a low functional capacity. Court-Brown and his colleagues [5] stated that surgery was not more advantageous than conservative treatment for two-part fractures in elderly patients (average age 72). In another study of the authors, good/excellent result of 80.6% in non-operative valgus impacted fractures was reported.[4] Additional trauma related to surgery should be taken into consideration while discussing this issue. Locking plate applications recommended recently are not free of problems.[7] Problems such as pull out of the head screws and varus malunion can be encountered in osteoporotic patients. Hemiarthroplasty, which can relief the pain and ensures limited function, is the first option to be considered for three or four-part fractures in elderly patients. The results of hemiarthroplasties which were obtained after secondary procedure due to malunion, were worse than the primary results.[25] Prothesis results were better in the patients who had conservative treatment at the beginning than the patients who underwent open reduction internal fixation.[38] Therefore, protection of the head and inclination with percutaneous fixation is advantageous for a future prothesis. Today, it is pointed out in many studies that tuberosite positions and the head height restoration should be well arranged in prothesis after fractures. [39-41] The results in young patients, who underwent percutaneous fixation, and two or three-part fractures are good, which is encouraging. Disadvantage of percutaneous fixation is the loss of reduction and fixation, which are obtained at surgery in the patients older than 60, in the following weeks. Having regard to the problems we have had, we recommend careful usage of percutaneous fixation in osteoporotic patients over 60 years of age because it might be difficult to complete the treatment by means of this method. One should remember that percutaneous pin fixation is a method, which is based on the skill of the surgeon, requires learning curve and is open to complications.

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