



AO tension band technique application in proximal humerus fractures

Proksimal humerus kırıklarında AO gergi bandı tekniği uygulaması

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Objectives: The aim of this study was to report our functional results after an intramedullary Kirschner wires (K-wires) and tension band wiring combination for the treatment of a large group of humeral head fractures was performed.

Patients and methods: Seventy-four patients (54 females, 20 males; mean age 42 years; range 24 to 73 years) who had proximal humerus fractures were treated with an intramedullary K-wire and tension band technique and were retrospectively analyzed. Fracture patterns were according to Neer classification type II in 43 patients, type III in 23 patients and type IV in five patients. The Constant-Murley shoulder score test was used to evaluate the function of both shoulders. The outcome was graded according to Neer's criteria. The pain score was determined with a 10-point visual analog scale.

Results: All fractures were healed (radiologically and clinically) within 3.6 months (range 2.5 to 4.7 months) after the surgery. In one patient, the cerclage wire was broken and in eight patients, K-wires produced impingement like symptoms that required a second procedure (wire removal) after healing. The results of the patients with regard to Constant-Murley score and Neer criteria were indifferent when the 6th and the 12th month data were compared ($p < 0.05$). Visual analog scale scores of the patients between the two control visits were significant different ($p > 0.05$).

Conclusion: The type of fixation depends on the bone quality and the degree of comminution. But the recent trend is towards osteosynthesis -the limited, less invasive technique- which is performed with minimal soft tissue dissection and minimal osteosynthesis. It allows less stripping of bone and therefore preservation of the blood supply to the humeral head. This procedure is simple to perform and provides good postoperative results.

Key words: AO tension band; humerus fractures; surgery.

Amaç: Bu geniş katılımlı çalışmada humerus başı kırıklarında intramedüller Kirschner teli (K-teli) ve gergi bandı kombinasyonu uygulanan hastaların fonksiyonel tedavi sonuçları değerlendirildi.

Hastalar ve yöntemler: Proksimal humerus kırığı nedeni ile intramedüller K-teli ve gergi bandı tekniği uygulanarak tedavi edilen 74 hasta (54 kadın, 20 erkek; ort. yaş 42 yıl; dağılım 24-73 yıl) geriye yönelik olarak değerlendirildi. Neer sınıflamasına göre değerlendirilen kırıkların 43'ü tip II, 23'ü tip III, beşi ise tip IV idi. Her iki omuza da Constant-Murley omuz skorlaması uygulanarak sonuçlar değerlendirildi. Sonuçlar Neer kriterlerine göre derecelendirildi. Ağrı, 10 puan üzerinden görsel analog skala ile değerlendirildi.

Bulgular: Tüm kırıklar (radyolojik ve klinik olarak) ameliyat sonrası ortalama 3.6 ayda (dağılım 2.5-4.7 ay) kaynadı. Bir hastada serklaj teli kırıldı, sekiz hastada ise intramedüller K-teli, kaynamadan sonra ikinci bir işlem gerektiren impingement sendromuna neden oldu. Sonuçlar 6. ve 12. aylarda Constant-Murley skoru ve Neer kriterlerine göre değerlendirildiğinde aralarında fark saptanmadı ($p < 0.05$). Bu iki kontrol arasında hastaların görsel analog skala değerleri arasında anlamlı fark saptandı ($p > 0.05$).

Sonuç: Yapılan tespitin tipi, kemiğin kalitesi ve kırığın çok parçalı olup olmasına bağlı olarak değişir. Ancak son zamanlarda güncel olan yaklaşım, minimal yumuşak doku diseksiyonu ile birlikte yapılan -sınırlı ve daha az invazif bir teknik olan- açık osteosentezdir. Bu sayede kemiğin daha az sıyırılması ve humerus başının beslenmesinin korunması hedeflenir. Bu yöntemin basit, kullanışlı ve ameliyat sonrası iyi sonuçlar veren bir yöntem olduğu görüldü.

Anahtar sözcükler: AO gergi bandı; humerus kırıkları; cerrahi.

The proximal humerus fracture is the second most common fracture of the upper extremities, following distal radius fractures,^[1] and constitutes about 4-5% of all fractures in adults.^[2] Despite advances in fixation techniques, the surgical treatment of fractures of the proximal humerus still remains a challenge.^[3] The reason for this is two-fold; first, these fractures are generally displaced fractures, and secondly, since they are usually seen in elderly patients with osteoporosis, they are comminuted fractures. Recent trends are toward minimal dissection and minimal osteosynthesis^[4-8] and some studies have been published in the relevant literature.^[9,10] In this study we aimed to report our functional results after using an intramedullary Kirschner wire (K-wire) and tension band wiring combination for the treatment of a large group of humeral head fractures.

PATIENTS AND METHODS

Between January 1999 and January 2006, we treated 74 patients (54 females, 20 males; mean age 42 years; range 24 to 73 years) having proximal humerus fractures with the intramedullary K-wire and tension band technique. The average follow-up period was 74 (range 44-128) months. The cause of injury in 59 patients was a fall episode and in 15 of the patients a traffic accident. All fractures were closed. Forty-six of the fractures were two-part (Figure 1), 23 were three-part and five were four-part fractures according to the Neer's classification.^[11] An X-ray and computed tomography (CT) of the shoulder were obtained to evaluate the fracture pattern. The time interval between the injury and the operation was within 8.3 (range 3.5-23.4) hours.

Surgical technique

The patients were placed in the beach-chair position on the operating table and fluoroscopy was used to obtain an intraoperative image when needed. A standard deltopectoral approach was performed. The fracture site was irrigated and all of the debris and hematoma were removed. Great care was paid during exposure and reduction to preserve all soft tissue attachments to the bone fragments. After acceptable fracture reduction, two 2 mm K-wires were inserted anterolaterally and posterolaterally along the nonarticular surface of the humeral head in a vertical manner. The intramedullary K-wires were kept strictly parallel so that the proximal fragment could slide on the wires and be com-

pressed to the distal fragment during tensioning of the cerclage wires (Figure 2). The tension band was localized in a way that it passed under the axillary nerve. A muscle bundle from the deltoid was inserted between the axillary nerve and the tension band. The K-wires were placed 2-3 cm apart from each other to increase rotational stability. With a 2.7 mm drill, two holes were made in the anterior humeral shaft at several centimeters distal to the fracture site. Cerclage wire was inserted around the K-wires and into the distal hole in a figure-eight fashion, with neither wire crossing the bicipital tendon. The cerclage wire was tightened to the free wire ends and in a loop to the other wire branch. Tightening was performed on both wire branches. The upper ends of the K-wires were then cut, bent and hammered into the humeral head.

Patient evaluation

Patients were discharged from the hospital after an average of four days. The patients were examined clinically and radiographically on the 6th and 12th months (Figure 3a, b). The Constant-Murley shoulder score test was used to evaluate the function of both shoulders.^[12] We also used Neer's criteria,



Figure 1. Preoperative anteroposterior radiography of a two part fracture.



Figure 2. Intraoperative anteroposterior radiography of a two part fracture treated with AO tension-band technique.

which grades the outcome as excellent, satisfactory, or unsatisfactory.^[13] The pain score was determined with a 10-point visual analog scale (VAS). Patients' data on the 6th and 12th month control visits were compared by Student t-test.

Postoperative treatment

Although postoperative rehabilitation depends on bone quality and fracture stability, every patient began early functional postoperative rehabilitation. Initially, the arm was immobilized in a sling for three to five days. Passive motions of the wrist and elbow were permitted. After 10 days, passive mobilization of the shoulder was started with the active assistance of a physiotherapist. Patients were encouraged to come to the outpatient clinic every other day for one month. In cases of severe osteoporosis (22 cases; 29%) and unreliable fracture stability, especially Neer type IV fractures, rehabilitation was initiated 15-20 days later. Active exercises were allowed six weeks after surgery and resistive exercises 10-12 weeks after surgery. After completing physiotherapy, patients were seen twice a year for the first year and once a year for the following years. Statistical evaluation was carried out with the use of SPSS 15.0 version for Windows (SPSS Inc., Chicago, Illinois, USA). The two sets of patients' scores were compared with a paired student t-test. Statistical significance was set at $p < 0.05$.

RESULTS

All fractures healed (radiologically and clinically) within 3.6 months (range 2.5-4.7 months) after surgery. One patient had undergone arthroplasty due to significant malreduction. In one patient the cerclage was broken, and in eight patients K-wires produced impingement-like symptoms

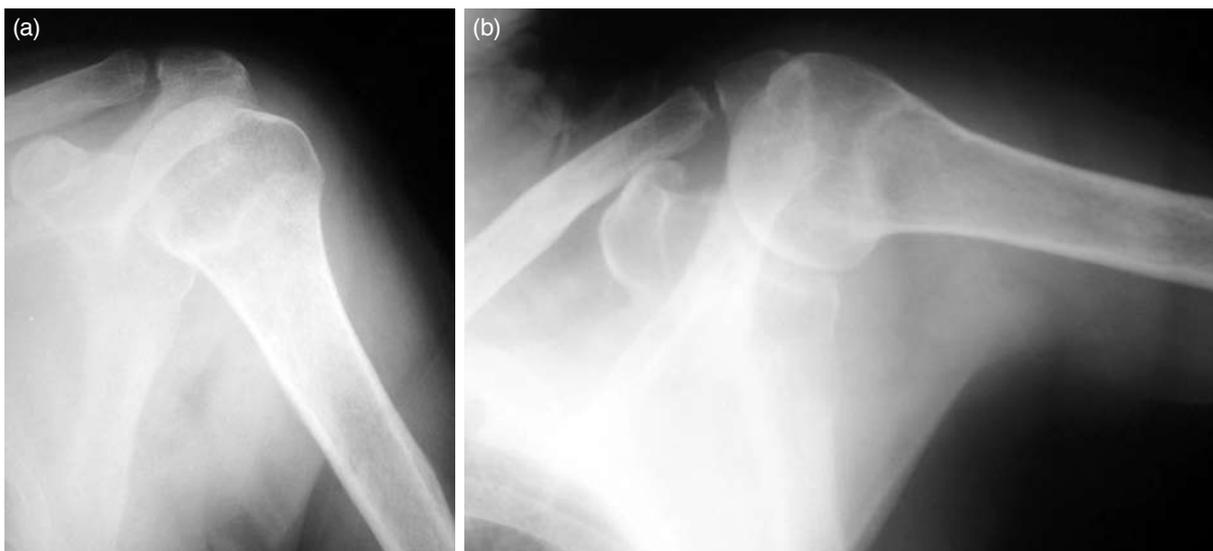


Figure 3. (a) Anteroposterior radiography after removal of the implants six months after the surgery. (b) Abduction radiography after removal of the implants six months after the surgery.

requiring a second procedure (wire removal) after healing. The implants of the other patients were not removed. There were no deep or superficial infections, neurovascular injuries or nonunion. Avascular necrosis was detected in one patient (1.7%) on the postoperative 30th month. This patient -with a Constant score of 70, VAS score of five and an unsatisfactory according to Neer criteria- was called for follow-up every six months. He rejected the option of hemiarthroplasty for the shoulder.

Sixty-one patients (82.4%) had a Constant score of 80 or more and 13 patients (17.6%) had a score less than 70 points at the 6th month. There were 41 (55.4%) excellent, 26 (35.1%) satisfactory, and seven (9.5%) unsatisfactory results at the 6th month. The average VAS score was two points (range 0-8) at the 6th month. Sixty-three patients (85.1%) had a Constant score of 80 or more and 11 patients (14.9%) had a score of less than 70 at the 12th month. There

were 45 (60.8%) excellent, 23 (31.1%) satisfactory, and six (8.1%) unsatisfactory results at the 12th month. The average VAS score was 1.4 points (range 0-5) at the 12th month.

The results of the patients with regard to Constant score and Neer criteria were undifferentiated when the 6th and the 12th month data were compared ($p < 0.05$). However, VAS scores of the patients between the two control visits showed statistically significant differences ($p > 0.05$). In three patients significant shoulder pain and stiffness developed and those symptoms were treated with intensive physiotherapy. They were found to be normal at the 12th month assessment. Sixty-one patients regained at least 90° abduction and flexion (Figure 4). Mean range of motion value for abduction was 117.6° (range 73°-132°) and for flexion 121.2° (range 83°-146°). Sixty-three patients were able to perform daily activities that they had performed before the injury. All of the patients



Figure 4. Range of motion six months after the surgery.

with poor results had three- or four-part fractures.

DISCUSSION

Many techniques of internal fixation have been reported in the literature.^[14-16] The type of fixation depends on the bone quality and the degree of comminution. Recent trends are towards limited soft tissue dissection and minimal osteosynthesis.^[4,5,7-9,17] It is important to consider that, if soft tissue hinges have been retained, the ultimate prognosis is good regardless of the number of fragments present.^[18] We have observed that patients who underwent limited soft tissue dissection and osteosynthesis tolerated active exercises well. Further, 82.4% of the patients who began active exercises in the early period have regained their preoperative activities.

This study demonstrated 91.9% of the patients experienced excellent or satisfactory results and 1.7% AVN. The results of our study support the hypothesized benefits of minimal dissection and validate the findings of other studies in the literature,^[18,19] while precluding hardware risks. The techniques performed in this series limit soft tissue dissection, helping preserve humeral head perfusion. Insofar as extensive soft tissue stripping is minimized, AVN may be decreased.

The primary concern in three- or four-part proximal humerus fractures is avascular necrosis of the head. Its reported prevalence has ranged between 0-90% in different series,^[14,17,20,21] and the incidence is higher in four-part fractures than in three- or two-part fractures.^[22] This complication is more common after open reduction with plates and screws, than after closed or limited open reductions and minimal osteosynthesis.^[23] Wijgman et al.^[8] observed no significant relationship between the surgical technique and the development of avascular necrosis, nor is there any definitive agreement on the correlation of avascular necrosis and poor clinical outcome. The low (1.7%) ratio of avascular necrosis in our series was considered to be due to the protection of the soft tissues nearby the fractures, minimal dissection, and the low number of patients with four-part fractures.

The technique of closed reduction and percutaneous pinning is preferred in young patients with two-part surgical neck fractures, but Soete et al. used this technique in elderly patients with three-

part fractures and also achieved positive results.^[24] This technique appears deceptively simple, but it is difficult and demanding. Complications include high incidence of malunion, pin tract infection, neurovascular injury, pin loosening and loss of fixation. Since we have performed open reduction in our patients, any malunion was not observed among those with two- and three-part fractures. However, in one patient (1.7%) with a four-part fracture malunion occurred. As the K-wires were inserted into the intramedullary canal by sight, we did not encounter any neurovascular complications, and as the K-wires were left inside the patient, any pin tract infection was unseen. The reason of the impingement syndrome in the initial eight patients (13.7%) was attributed to the excessive length of the bent K-wires. A similar complication did not ensue thereafter.

The four patients who had four-part fractures were operated on as the other patients, but hemiarthroplasty was performed on one of them due to a failure of the reduction. Although we have not used a proximal humerus locking plate technique in any of our subjects, the recent literature strongly suggests this technique for three- and four-part fractures.^[25-27]

Intramedullary nails have also been used for these patients with acceptable results.^[6,16,17,20,28] However, these nails offer limited rotational control. Locked humeral nails provide better rotational control but require a larger hole in the rotator cuff for insertion.^[28] Thus overall, our technique seems to cause less injury to the rotator cuff.

In conclusion, less invasive techniques allows less stripping of bone and therefore preservation of blood supply to the humeral head. Due to reduced adhesions, no aggressive rehabilitation is necessary. This procedure is simple to perform and provides good results.

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