



Effect of Comorbidities and Choice of Fixation on the Onset of Bone Healing Time on Surgically Treated Intertrochanteric Femoral Fractures

Cerrahi Olarak Tedavi Edilen İntertrokanterik Femur Kırıklarında Eşlik Eden Durumların ve Fiksasyon Seçiminin Kemik İyileşme Süresinin Başlangıcına Etkisi

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ABSTRACT

Objective: This study aimed to evaluate whether comorbidities affect the onset of bone healing time (BHT) in surgically treated intertrochanteric femoral fractures (IFFs).

Methods: The study comprised 55 patients (12 male and 43 female) who underwent surgical treatment of IFFs. The mean age of patients was 79.29±81.13 years. The fractures were classified according to the AO Classification. Twenty-one patients were treated with dynamic hip screw, 15 with an external fixator, and 19 with proximal femoral nail. Thirty-one patients had comorbidities such as diabetes and hypertension.

Results: Patients were divided into three groups according to the BHT. Group 1 had BHT<30 days (G1), group 2 had BHT 30-60 days (G2), and group 3 had BHT >60 days (G3). There were no statistically significant differences among the groups in terms of age, sex, additional disease, and the fixation method. There were statistically significant differences among the groups in terms of receiving intensive care unit (ICU) treatment. The rates of ICU referral in G3 were significantly higher than those in G1, statistically close to being meaningfully higher than those in G2. Discharge duration was close to being meaningful in patients with more than one comorbidity.

Conclusion: Fixation type, age, and comorbidities did not affect BHT. Patients with more than one comorbidities had long hospitalization time owing to their prolonged preoperative surgical preparation time and postoperative evaluation of comorbidities.

Keywords: Intertrochanteric femoral fractures, fracture healing, fixation method, proximal femoral nail, dynamic hip screw

ÖZ

Amaç: Bu çalışmanın amacı intertrokanterik femur kırıkları (IFK) olan hastaların cerrahi tedavisinde komorbiditelerin ve fiksasyon yöntemlerinin, kaynamaya başlama süresini (KBS) etkileyip etkilemediğini değerlendirmektir.

Gereç ve Yöntem: Çalışmaya IFK nedeniyle cerrahi tedavi uygulanan 55 hasta (12 erkek ve 43 kadın) alındı. Hastaların yaş ortalaması 79,29±81,13 yıl (61,6 ile 91,5 yıl arasında değişmekteydi). Kırıklar AO sınıflamasına göre sınıflandırıldı. Yirmi bir hasta dinamik kalça vidası (DHS) ile tedavi edildi, 15 hasta eksternal fiksator (EF) ile tedavi edildi, 19 hasta proksimal femoral çivi (PFN) ile tedavi edildi. Otuz bir hastanın diyabet, hipertansiyon vb. gibi ek hastalıkları vardı.

Bulgular: Hastalar kaynamaya başlama süresine göre üç gruba ayrıldı. KBS'si <30 gün grup 1 (G1), 30-60 gün grup 2 (G2), >60 gün grup 3 (G3) olarak değerlendirildi. Gruplar arasında (G1, G2, G3) yaş, cinsiyet, ek hastalık ve fiksasyon yöntemi açısından istatistiksel olarak anlamlı bir fark saptanmadı. Gruplar arasında postoperatif dönemde yoğun bakım ünitesine (YBÜ) refere edilme oranı açısından istatistiksel olarak anlamlı farklar vardı. G3'te YBÜ refere edilme oranları G1'den anlamlı olarak yüksekti, istatistiksel olarak G2'den anlamlılığa yakın yüksekti. Birden fazla komorbiditesi olan hastaların hastanede yatış süresi diğer hastalardan anlamlılığa yakın derecede yüksekti.

Sonuç: Fiksasyon tipi, yaş ve komorbiditelerin KBS'sini etkilemediği gözlenmiştir. Birden fazla komorbiditesi olan hastaların, uzun preoperatif cerrahi hazırlık süresi ve ek hastalıkların postoperatif dönemde kontrol edilmesi nedeniyle hastanede yatma sürelerinin daha uzun olduğu gözlemlendi.

Anahtar Kelimeler: İntertrokanterik femur kırıkları, kırık iyileşmesi, fiksasyon tekniği, proksimal femoral çivi, kayan kalça vidası

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INTRODUCTION

Intertrochanteric femur fractures (IFFs) are common in elderly patients, especially in post-menopausal women, usually due to low-energy trauma such as simple falls (1). However, these can also occur in young patients following high-energy trauma, such as vehicle injuries (2). In the near future, the geriatric population will probably increase, and the incidence of osteoporotic bone fractures will be seen in orthopedic practice. In 1990, 26% of all hip fractures occurring in Asia were IFFs; however, this incidence is expected to reach 37% in 2025 and 45% in 2050 (3). The goal of treating IFFs is to ensure stable fixation for early mobilization and return to pre-fracture activity levels. Early mobilization is important for preventing complications, such as deep vein thromboembolism and decubitus ulcers, as well as for improving patient functions (4).

Patients with IFFs are at a risk of significant morbidity and high mortality (5,6). In elderly patients, IFFs are usually associated with comorbidities such as diabetes; hypertension; pulmonary, renal, and cardiac conditions (7). Early reduction and stable surgical fixation of these fractures prevent complications such as avascular necrosis and non-union as well as allows early mobilization (8). Comorbidities increase the risk of surgery in these patients.

Previous studies on IFFs usually examined the effect of fixation techniques on aspects such as union, stabilization, and weight-bearing time (7,8). This retrospective study aimed to evaluate whether comorbidities have an effect on the onset of bone healing time after the surgical treatment of IFFs. In addition, we hypothesized that patients with comorbidities have a delayed onset of healing time.

METHODS

All patients who underwent surgical correction for IFFs between January 2014 and January 2015 were retrospectively investigated after the University of Health Sciences Turkey, Bakirköy Dr. Sadi Konuk Training and Research Hospital Approval of the Local Ethics Committee (IRB approval no: 2015/16/10). Data were collected both from patient files and electronic medical records. Age, sex, length of hospital stay, concomitant disease, discharge disposition, intensive care requirement, and fixation type were evaluated based on patient medical records (Table 1). Inclusion criteria were as follows: age >60 years; closed fractures; closed reduced fractures; AO-31-A1, A2, and B3 fracture types; unilateral fractures; anatomic or near anatomic reduction; and no accompanying lower limb fracture. Exclusion criteria were as follows: age <60 years; undergone hemiarthroplasty;

pathological fractures; AO-31-A3, B1-2 type fractures; open fractures; accompanying lower limb fracture; non-anatomic reduction; and reoperated patients. Standard preoperative planning was conducted. Radiographs of the pelvis with both hips anteroposterior and the lateral view were obtained to confirm the diagnosis. Dynamic hip screw (DHS), proximal femoral nail (PFN), or external fixation (EF) were the commonly used methods for IFF fixation. Materials for use during surgery were selected according to the surgeons' preference. All three fixation materials are frequently used in our clinic and daily orthopedic practice. No specific selection criteria were used. All IFFs were performed by closed reduction using traction table and C-arm fluoroscopy. The reduction criteria were based on the study by Fogagnolo et al. (9). Patients were mobilized on the postoperative day 2. The PFN group was subjected to full weight-bearing during the early postoperative period. The DHS and EF groups were subjected to only partial weight-bearing. Sutures were removed on the 14th or 15th day. X-rays were obtained in the 2nd week and 1st, 2nd, 3rd, 6th, and 12th month postoperatively. Three

Table 1. Distribution of demographic characteristics

		Min-Max	Mean ± SD
Age (years)		61.6-91.5	79.29±81.13
Hospitalization (days)		2-28	15±6.74
		n	%
Sex	Female	43	78.2
	Male	12	21.8
AO classification	31.A1.2	30	54.5
	31.A1.3	9	16.3
	31.A2.2	10	18.2
	31.B3	6	11
Comorbidities	Hypertension	16	29.1
	Diabetes	7	12.7
	Chronic renal failure	4	7.2
	Cardiac disease	4	7.2
	Cancer	3	5.5
	COPD	2	3.6
	Alzheimer's disease	3	5.5
ASA score	1	4	7.2
	2	45	82
	3	5	9
	4	1	1.8

ASA: American society of anesthesiology, COPD: Chronic obstructive pulmonary disease, SD: Standard deviation, Min-Max: Minimum-maximum

orthopedic surgeons (with at least 10 years' experience in trauma surgery) reviewed preoperative and postoperative anteroposterior and lateral X-ray reports of each patient. The surgeons consensually decided the onset of healing time, according to callus formation on anteroposterior and frog-leg hip X-rays. The union times of IFFs were evaluated radiologically and clinically. The surgeons noted the healing time. The callus formation on three cortices was used for determining healing time. Clinical findings such as joint motion and pain with weight-bearing were collected from patient medical records.

Patients were divided into three groups according to the onset of union time. The postoperative radiographs of patients were evaluated, and the onset of union time was recorded. Radiographic evaluations included callus formation on the fracture side, shortening of the femoral neck length, lateral migration of the helical screw, and cortical thickening of the fracture site. The radiological finding of fracture healing was first observed at <30 days in the first group (G1), 30-60 days in the second group (G2), and >60 days in the third group (G3).

Statistical Analysis

Statistical analysis was performed using the NCSS (Number Cruncher Statistical System) 2007 (Kaysville, Utah, USA). Many-Whitney U test was performed for descriptive statistical method evaluation (average, standard deviation, median, frequency, ratio, minimum, and maximum) and for comparing non-normally distributed data. Kruskal-Wallis test was used for comparing non-normally distributed quantitative data of three and upper groups. Bonferroni correction Dunn's test for conducted for determining the diversity group. Pearson ki-square test, Fisher-Freeman-Halton test, Fisher's Exact test, and Yates were used for qualitative data comparison. P-values were considered statistically significant when $p < 0.01$ and $p < 0.05$.

RESULTS

The demographic features of study patients are presented in Table 1. Thirteen patients had one comorbidity and 18 had more than one comorbidity. Twenty-one patients were operated with DHS, 15 with EF, and 19 with PFN. Four patients were referred to the critical care unit. There were no statistically significant differences among the groups (G1, G2, G3) in terms of age, sex, additional disease, and the fixation method ($p=0.377$, $p=0.373$, and $p=0.792$, respectively). Interobserver There were statistically significant differences among the groups in terms of receiving intensive care ($p=0.021$). According to post-hoc binary comparisons made to identify the group that was

responsible for the difference, the rates of intensive care referral in G3 were significantly higher than those in G1 ($p=0.026$), statistically close to being meaningfully higher than those in G2 ($p=0.055$; $p > 0.05$), and no difference in G1 and G2 ($p=1.000$) (Table 2). According to the type of fixation and additional disease, there were no statistically significant differences in the rate of referral to the intensive care unit (ICU) ($p=0.183$ and $p=0.123$, respectively) (Table 3). The time interval between the operation to discharge day and ICU referral showed a statistically significant difference in terms of the onset of bone healing ($p=0.0021$ and $p=0.041$, respectively) (Table 4). There was no statistically significant relationship of the number of comorbid diseases with the onset of healing and ICU referral. The duration of discharge had close to statistically significant difference between patients who have only one and more than one comorbidities ($p=0.053$) (Table 5).

Table 2. Post-hoc binary comparisons in terms of intensive care referral and discharge day

	<30 days 30-60 days	<30 days >60 days	30-60 days >60 days
^{aa} Discharge day (day)	1.000	0.084	0.048*
^{bb} Intensive care referral	1.000	0.026*	0.055

^{aa}Bonferroni corrected dunn's test, ^{bb}Fisher's Exact test, * $p < 0.05$, statistically significant p values were marked bold

Table 3. The relationship between referral to intensive care unit and comorbidities and types of fixation

		Intensive care		P
		Not referred n (%)	Referred n (%)	
Comorbidities	No	24 (100)	0 (0)	^a 0.123
	Yes	27 (87.1)	4 (12.9)	
Type of fixation	DHS	21 (100)	0 (0)	^b 0.185
	EF	13 (86.7)	2 (13.3)	
	PFN	17 (89.5)	2 (10.5)	

^bFisher-Freeman-Halton test, ^aFisher's Exact test, DHS: Dynamic hip screw, EF: External fixation, PFN: Proximal femoral nail

DISCUSSION

The key question we raised in the introduction of this study was whether there were any effects of comorbidities on the healing IFFs. We hypothesized that a delayed onset of callus formation occurs in patients with comorbidities. In the three groups, there were no statistical differences at the beginning of the callus formation. We did not observe

Table 4. The relationship between the onset of bone healing and the type of fixation duration of intensive care referral and discharge day

<30 days (n=33)		Onset of bone healing			p
		30-60 days (n=13)	>60 days (n=9)		
Type of fixation	DHS	13 (39.4)	7 (53.8)	1 (11.1)	b0.332
	EF	8 (24.2)	3 (23.1)	4 (44.4)	
	PFN	12 (36.4)	3 (23.1)	4 (44.4)	
Intensive care unit	Not referred	32 (97.0)	13 (100)	6 (66.7)	b 0.021*
	Referred	1 (3.0)	0 (0)	3 (33.3)	
Time interval between operation to discharge day	Min-Max (median)	1-25 (4)	1-10 (5)	0-9 (2)	* 0.041*
	Mean ± SD	6.00±6.28	5.23±2.98	2.44±2.79	
Time interval between admission and discharge day	Min-Max (median)	0-28 (12)	2-27 (11)	10-26 (17)	e0.102
	Mean ± SD	12.73±6.48	13.69±8.76	17.67±4.64	

*Kruskal-Wallis H test, bFisher-Freeman-Halton test, *p<0.05, statistically significant p values were marked bold, DHS: Dynamic hip screw, EF: External fixation, PFN: Proximal femoral nail, SD: Standard deviation, Min-max: Minimum-maximum

Table 5. Comparison of time of bone healing, duration of intensive care, and discharge period according to the count of the comorbid disease

		Count of the comorbid disease		P
		1 disease (n=13)	>1 disease (n=18)	
Beginning of healing (day)	<30 days	7 (53.8)	11 (61.1)	b0.423
	30-60 days	2 (15.4)	5 (27.8)	
	>60 days	4 (30.8)	2 (11.1)	
Intensive care	Not referred	10 (76.9)	17 (94.4)	d0.284
	Referred	3 (23.1)	1 (5.6)	
Duration of discharge (day)	Min-max (median)	0-9 (3)	2-25 (4)	e0.053
	Mean ± SD	3.31±2.81	7.11±6.60	

bFisher-Freeman-Halton test, dFisher's Exact test, eMann-Whitney U test, SD: Standard deviation, Min-max: Minimum-maximum

any effects of additional diseases such as diabetes mellitus, coronary artery disease, and chronic renal failure. These comorbidities affect the duration of hospitalization. There was no statistical relationship between comorbidities and ICU referral, but all patients referred to ICU had comorbidities. Patients who had more than one additional disease had a longer hospital duration than the others. Bennett et al. (10) emphasized that hospitalization time was delayed in older patients who had an additional disease and proximal femoral fracture. The duration of admission time to surgical time is delayed in these patients because they require additional disease management such glucose regulation and waiting for lack of bed in the ICU (2).

DHS has been used for a long time for ensuring stable extra-capsular intertrochanteric femoral fractures (11). Reportedly, DHS has increased the failure rate of unstable fractures and reverse obliquity fractures (12,13). PFN is also used for treating proximal femoral fractures. PFN was developed by AO/ASIF for proximal femoral fractures for preventing gamma nail complications (14). A 6.5 mm anti-rotation hip screw decreases the incidence of implant cut-out, and a smaller diameter and fluting of the tip of the nail reduces the distal forces, which can prevent distal femoral fractures (15). EF is a fast and minimally invasive method for IFF stabilization (16). EF is used for reducing surgery duration and intraoperative bleeding. Edipoğlu et al. (17) reported that EF reduces surgery time and intraoperative bleeding compared to PFN and DHS. DHS, PFN, and EF are minimally invasive methods for fixation of proximal femur fractures, and these methods do not dramatically increase surgical damage (18). In our study, there was no statistical relationship between the onset of callus formation and fixation type. We believe that there was no difference between the onset of union time because the three fixation types provide similar and essential stability for bone healing. In addition, ICU referral was not related to the type of fixation. Patients in the three groups did not differ in terms of age, sex, and mean duration of hospitalization stay. As the three fixation types used are minimally invasive surgical procedures, their effect on the medical status of the patients and the referral of ICU was similar.

Reportedly, comorbidities decreased soft tissue nutrition (19). In our study of older patients with comorbidities, we observed that this decreased soft tissue nutrition did not affect the onset of healing because the hip joint was

covered with sufficiently thick soft tissue and because the fixation types were stable. We noted delayed union in patients who were admitted to the ICU. Patients who were referred to ICU have limitations for mobility, and we believe this causes delayed union. However, we could not observe any relationship between the admission of patients with multiple comorbidities to the ICU. Multiple comorbid diseases result in higher ASA classifications. ASA 3 and 4 patients require longer hospitalization time from admission to surgery (20).

In the current study, patients with comorbidities had longer hospitalization stays. Additional diseases and older age result in long-term preparation of patients, especially before surgery (21,22). In patients with comorbidities, the risk of referral to ICU is increased; similarly, massive blood loss is noted in the postoperative period (22-24). The present study also showed that patients with comorbidities were hospitalized for longer periods due to preoperative preparation and postoperative care period. We consider that a multidisciplinary evaluation is necessary for such patients, which ultimately prolongs hospitalization.

Study Limitations

The limitations of the study were its retrospective design, a relatively small number of patients, and no randomization. In contrast, the strength of the study is in its contribution to the limited number of studies investigating the effect of comorbid diseases on fracture healing with different fixation techniques.

CONCLUSION

There is no relationship between the onset time of union and comorbidities. However, we detected a delay of the onset of union time in patients who were referred to the ICU and noted a longer hospital stay in patients with more than one comorbidities.

ETHICS

Ethics Committee Approval: The study were approved by the Local Ethics Committee of University of Health Sciences Turkey, Bakirköy Dr. Sadi Konuk Training and Research Hospital (IRB approval no: 2015/16/06).

Informed Consent: Informed consent was obtained from all individual participants included in the study.

Authorship Contributions

Surgical and Medical Practices: A.B., A.D., Concept: A.B., A.D., Design: A.B., A.D., Data Collection or Processing: A.B., A.D., Analysis or Interpretation: A.B., A.D., Literature Search: A.B., A.D., Writing: A.B., A.D.

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