Markers of muscle damage for comparing soft tissue injury following proximal femur nail and dynamic hip screw operations for intertrochanteric hip fractures

Yonathan Wagman, MD[a,1,*], Ortal Segal, MD[b,1], Israel Dudkiewicz, MD[c], Ely Steinberg, MD[b]

[a] Department of Plastic Surgery, Hadassah Medical Center, Hebrew University School of Medicine, Jerusalem, Israel
[b] Orthopaedic Division, Sourasky Tel-Aviv Medical Center, Tel-Aviv University, Israel
[c] Orthopaedic Rehabilitation Unit, Department of Rehabilitation, Sourasky Tel Aviv Medical Center, Tel-Aviv University, Israel

A B S T R A C T

Background: Femoral neck fractures are the most common fractures among the elderly. The two operative approaches used for the treatment of AO/OTA 31 intertrochanteric fractures include an intramedullary device (proximal femoral nail [PFN]) or an extramedullary device (sliding/dynamic hip screw [DHS]). The aim of this study was to provide objective evidence of local soft tissue injury by measuring serum creatine phosphokinase (CPK), a biochemical marker, to quantify muscle damage and inflammation in patients treated by the two approaches.
Patients and methods: Medical data of 359 patients operated for intertrochanteric fractures with PFN (156 patients) or DHS (193 patients) were retrospectively reviewed. The fractures were classified according to AO/OTA classification. Perioperative and radiographic data were collected to ensure cohorts with similar characteristics. Serum CPK and serum hemoglobin (Hb) levels were measured preoperatively and on postoperative day 1 (POD1). Independent predictors of elevation in the levels of markers of inflammation and muscle damage were determined by a multivariate linear regression model.
Results: The demographics were similar for the two groups. Our study population included 64.2% female patients. Preoperative serum CPK levels were available for 89 patients and POD1 serum CPK levels were available for all patients. One-hundred and thirteen of the 193 DHS patients (58%) and 14 of the 156 PFN patients (9%) had a stable fracture (AO/OTA 31A1, $p < 0.0001$). The DHS patients had a greater increase between pre- and postoperative CPK levels compared to the PFN patients (DHS, $\delta = 368$ versus PFN, $\delta = 65$, $p < 0.0002$). The PFN patients had a greater decrease in both the pre- and postoperative Hb levels compared to the DHS patients (Diff_Hb 0.27 g/dl). The older the patient, the greater decreases in Diff_CPK compared to the younger ones.
Conclusions: Implementation of POD1 CPK blood levels as a biochemical marker of soft tissue injury provided quantitative evidence that patients whose intertrochanteric fracture was stabilized by a DHS suffered greater soft tissue injury compared to patients whose fracture was stabilized by a PFN.

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Introduction

The annual occurrence of intertrochanteric hip fractures among older women in the USA is ∼63 cases per 100,000 women compared to ∼34 cases of older men per 100,000 men [1]. Some of the causes for an intertrochanteric fracture, rather than a femoral neck fracture, include advanced age, limitation to home ambulation, higher dependence for basic and instrumental activities of daily living, and history of other osteoporotic fractures [2]. The standard surgical treatment for intertrochanteric fractures of the proximal femur is early surgical fracture stabilization. There is a wide variety of devices used to stabilize these fractures, and most of them belong to two groups, cephalocondylic intramedullary nails (e.g., proximal femur nails, PFNs), which are inserted into the femoral canal proximally to distally across the fracture, and extramedullary implants (e.g., dynamic hip screws, DHSs). Although both types of devices have been in use for more than three decades, there is no clear-cut evidence to indicate which

* Corresponding author at: Sourasky Tel-Aviv Medical Center, Israel.
  E-mail address: w.yonatan@gmail.com (Y. Wagman).
[1] These authors contributed equally to this article.

of them is the preferred one [3]. The latest relevant publication showed no benefit for one over the other in terms of reoperation rates and significant complications [4].

There are relatively few investigations of soft tissue injury following femur neck fracture repair. Those publications compared only the C-reactive protein (CRP) values of five surgical approaches in patients with proximal femur fracture [5]. Differences in soft tissue serum markers were reported in a single relatively small preliminary study (20 patients) on DHS and PFN surgeries for AO 31 A1 or 2 fractures [6].

Analysis of soft tissue injury by means of muscle damage helped to establish the rationale for a laparoscopic cholecystectomy [7], hernia repair [8] and hysterectomy [9]. It was also used to compare minimally invasive versus a standardized posterior surgical approach in total hip arthroplasty [10,11,12]. A comparative study on minimally invasive direct anterior versus posterior total hip arthroplasty based on inflammation and muscle damage showed that the anterior approach causes the least damage to muscle tissue [6]. A similar technique was recently used for examining several surgical approaches in total knee arthroplasty and the results showed varying increases in the cytokine levels [13].

The degree of soft tissue damage invariably influences the patient's rehabilitation and functionality after the surgery. The aim of this retrospective study was to compare serum biochemical indices representing the degree of muscle damage and inflammation factors between patients undergoing DHS or PFN surgery for intertrochanteric hip fractures in the Orthopedic Trauma Unit.

Patients and methods

After receiving approval of our ethics committee, we reviewed the electronic database of **our** Orthopedic Trauma Unit between November 2011 and May 2013. Data on patients with a 31A intertrochanteric fracture according to AO/OTA classification who were treated with PFN or DHS were retroprospectively analyzed. Preoperative and radiographic data were collected to ensure cohorts with similar characteristics. **All patients were operated within 48 hours after arriving to the Emergency Room.**

There were 193 patients in the DHS group of whom 124 (64.2%) were females, and 156 patients in the PFN group of whom 107 (68.5%) were females. The DHS patients' mean age was 82.5 years (range 30–104, SD 10.18 years, median 85 years) and the PFN patients' mean age was 82.8 years (range 25–100, SD 10.27 years, median 85 years). The respective mean Charlson comorbidity score was 5.56 (SD 1.49, median 5) and 5.56 (SD 1.53, median 5), respectively. The demographic, clinical and laboratory data are presented in Table 1. Serum creatinine phosphokinase (CPK) levels were measured preoperatively and on postoperative day 1 (POD1). The POD1 CPK level was collected from 349 patients, 193 (median 522, SD 384.56) of whom underwent the DHS approach and 156 (median 250, SD 361.21) of whom underwent the PFN approach. The preoperative serum

Table 1
Basic Demographics, clinical and laboratory data.

	No. patients	DHS	No. patients	PFN
AGE (median)	193	85 y	156	85 **y**
SEX M:F	193	1:1.8	156	1:2.2
CHARLSON SCORE	193	5	156	5
FIRST Hb	193	12.3	156	11.9
FIRST CPK	51	95	38	90
POD1 CPK	193	500	156	250
POD1 CRP	154	86	118	89
POD1 HB	193	9.6	156	9.1

First CPK and First Hb levels: samples taken at admission to the Emergency Room; POD1: levels at postoperative Day 1.

CPK levels were available for only 51 (median 95, standard deviation [SD] 129) DHS patients and 38 (median 90, SD 250.57) PFN patients since CPK is not routinely assessed preoperatively.

The values for serum CPK and serum Hb, albumin and CRP levels that were included in the current analysis were taken from the first samples after hospital arrival prior to surgery and those from samples taken on POD1. Fracture type was assigned according to the AO/OTA fracture classification.

Statistical analyses

Wilcoxon scores were used for differences in CPK values (Diff_CPK) for all variables without normal distribution. Descriptive statistics are given as median and interquartile range or mean and SD for continuous variables, and as frequency distribution for categorical variables. Examination of the relations between surgery type and clinical and demographic factors was performed using the *t*-test, Mann-Whitney, Chi-square and Fisher's Exact tests, as appropriate. A multivariate linear regression model was applied to the data to simultaneously study the independent relationship between each predictor and the change in CPK values. The variables included in the model were surgery type (PFN or DFS), age, EG_CharlsScore, diff_hb, SexCode, and AO_classification_31A. The forward stepwise regression method was used for building a parsimonious model with the inclusion criteria of Schwarz Bayesian information criterion. Statistical analysis was performed by SAS for Windows version 9.2.

Results

The patients were classifieds by fracture type according to the AO/OTA classification: 113/193 (58%) DHS patients and 14/154 (9%) PFN patients had a 31A1 fracture, 78/193 (40%) and 71/154 (46%) had a 31A2 fracture, and 2/193 (1%) and 69/154 (44%) had a 31A3 fracture. Distribution of the groups by fracture classification is shown in Table 2.

CPK

There were 51 DHS and 38 PFN patients for whom CPK measurements were available both at the time of admission and on

Table 2
Group analysis based on Type 31A fracture, according to the AO/OTA classification.

AO/OTA Classification	Study Group		
	DHS	PFN	Total
31 A1	113	14	127
Frequency (n)	32.56	4.03	36.60
Percent from total%	88.98	11.02	
Row percent%	58.55	9.09	
Column percent%			
31 A2	78	71	149
Frequency (n)	22.48	20.46	42.94
Percent from total%	52.35	47.65	
Row percent%	40.41	46.10	
Column percent%			
31 A3	2	69	71
Frequency (n)	0.58	19.88	20.46
Percent from total%	2.82	97.18	
Row percent%	1.04	44.81	
Column percent%			
Total	193	154	347
Frequency (n)	55.62	44.38	100.00
Percent from total%			