Analysis of Factors Affecting Return to Work After Surgical Treatment in Patients with AO Type C Distal Humerus Fractures

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Abstract

Background The purpose of this study is to evaluate the functional results of distal humerus fractures which were treated by open reduction and fixation with pre-contoured angular stable plates in young patients, and investigate whether the patients could return to their pre-injury work and patients' financial conditions while they were not working.

Materials and Methods The data of 48 patients, ages between 18 and 55 years, working in a job and having AO/OTA type C distal humerus fracture were retrospectively evaluated. Mayo Elbow Performance Score (MEPS) was used to determine functional results. Postoperative radiographs were evaluated to determine the rate of union, degenerative changes, malunion and heterotopic ossification. Financial outcome form was constituted by the authors and the patients asked whether she/he could return to their pre-injury works after treatment finished and the financial status of the patients during the treatment and after the treatment.

Results The mean flexion–extension arc was $114^{\circ} \pm 12^{\circ}$ (range 85° – 135°) and the mean MEPS score was 85 ± 11 (range 65–100). The average time to return to work was 6.5 ± 2.4 months (3–12 months). AO type C2 and C3 fractures and heterotopic ossification negatively affected the functional results and also adversely affected the patients' return to their pre-injury works. 38 (79%) patients returned to pre-injury work and 29 (76%) of them started to work at the same position before the fracture occurred. Nine of 38 patients (24%) had to change their positions. Among the 48 patients, 10 patients (21%) could not return to the same work, 7 of them found light duty and 3 of them had not been to work.

Conclusion Although the functional results of surgical treatment of intra-articular distal humerus fractures are good, at the end of the treatment, especially heavy workers may have difficulties in returning to their former works.

Keywords Distal humerus fracture · Angular stable fixation · Functional results · Return to pre-injury work

Introduction

Intra-articular distal humerus fractures (DHF) are relatively rare injuries and constitute approximately 2% of all fractures [1]. Like all other intra-articular fractures, an anatomic reduction of the articular surface and rigid fixation of the fracture which can tolerate early range of motion are

mandatory for success of the treatment. The aim of the treatment of these fractures is to achieve an elbow which is painless, stable, and mobile. The rehabilitation process is very important both for the patient to be functionally independent and to return to pre-injury work. However, the complexity of the anatomy, possible soft tissue contractures and heterotopic ossifications can all affect the success of the treatment adversely [2–5].

Distal humerus fractures often occur with low-energy trauma in elderly and osteoporotic patients and resulting in higher-energy trauma in young, active and working adults [1, 3]. Especially, working accidents and traffic accidents cause distal humeral fractures and these fractures cause the patients to return to their jobs late or to have to change their jobs or positions. Although scoring systems such as Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire and general health status measured with the Short Form-36

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(SF-36) survey, mental component summary (MCS) and physical component summary (PCS) were used in determination of returning to work after upper extremity injuries, we could not find any information about type C distal humerus fractures [6].

There are many studies about the results of distal humeral fracture treatment [7–13]. However, none of these studies evaluates return of the patients to their pre-injury works and the possible financial effects of this injury on the patients. Returning to pre-injury work is a necessity for most of the fractured patients because of financial issues. The purpose of this study is to evaluate the functional results of DHF, which were treated by open reduction and fixation with pre-contoured angular stable plates in young patients, and investigate whether the patients could return to their pre-injury occupation level and patients' financial conditions while they were not working.

Our hypothesis is that the patients who had intra-articular DHF treated with open reduction and internal fixation may have difficulty returning to their pre-injury works, even though their functional results are good.

Materials and Methods

The patients who had intra-articular DHF treated with open reduction and pre-contoured angular stable plate fixation between January 2010 and January 2017 were evaluated retrospectively. The patients between 18 and 55 years of age, working in a job and having type C distal humerus fracture according to AO/OTA (Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association) classification system were included in the study. Exclusion criteria were: extra-articular and partial articular distal humerus fractures (AO type A and B), previous operative treatment because of the upper extremity fracture, history of primary or metastatic tumors with pathologic fractures, other additive upper and/or lower extremity injuries and unemployed patients.

When the patient records were examined in the light of these criteria, 56 active, employee patients of ages between 18 and 55 years who had type C distal humerus fractures and treated with open reduction and plate osteosynthesis were found. Six patients could not be reached due to address and phone change and two patients refused to participate in the study. Totally, 48 patients were included in the study. The medical records were reviewed retrospectively, and the patients were invited to return for a comprehensive follow-up evaluation under a protocol approved by the Local Ethical Committee. The protocol for collecting the data of human subjects was approved by the hospital ethics committee, and the study was conducted in accordance with the standards of the Declaration of Helsinki (Finland).

Preoperative anteroposterior (AP) and lateral views were obtained to analyze the fracture. After evaluating the pre-operative X rays and CT scans, fractures were classified according to AO/OTA classification system. There were 29 (60.4%) type C1, 13 (27.1%) type C2 and 6 (12.5%) type C3 fractures (Table 1). There were four (8%) type 1 open fractures according to Gustilo–Anderson classification system [14].

Olecranon osteotomy or paratricipital approach was used in 40 (83.4%) and 8 (16.6%) elbows, respectively. The medial and lateral column fixation was performed in all fractures with pre-contoured anatomic locking anatomic plates which were positioned perpendicular to each other. If the medial plate irritated the ulnar nerve after osteosynthesis, the nerve was transported to the anterior, subcutaneously. The olecranon osteotomies were fixed with tension band wiring technique in 37 (93%) patients and by 6.5 mm partially threaded cancellous screw in 3 (7%) patients. The arm was put on a splint until edema resolved.

If the osteosynthesis was considered as stable under visual control intraoperatively, active-assisted range of motion exercises of the elbow were initiated 2–3 days after the operation under the supervision of a physiotherapist. During outpatient clinic controls, the patients who did not have sufficient improvement in the flexion arc were included in the rehabilitation program with a physiotherapist. Patients were followed up on the 15th day, 6th week, and 3, 6 and 12th months with regular clinical and radiographic review. At the last visit, the range of motion of the elbow was measured with a goniometer. Mayo Elbow Performance Score (MEPS) was used to determine functional results [15].

Table 1 Demographic data of the patients

Characteristics	Patients (n:48)
Age (years) Mean + SD	38.1 (range 19–55)
Gender, n (%)	
Male	36 (75%)
Female	12 (25%)
Cause of injury, n (%)	
Working accident	20 (42%)
Simple fall	15 (31%)
Fall from height	7 (14%)
Traffic accident	6 (13%)
Fracture type (AO/OTA), n (%)	
C1	29 (60.4%)
C2	13 (27.1%)
C3	6 (12.5%)
Open fracture, n (%)	4 (8%)
Mean follow-up (months)	39 (range 12–84)

AO/OTA Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association

Postoperative anteroposterior and lateral radiographs were evaluated to determine the rate of union, possible changes in hardware position, articular step-off, varus–valgus angulation and heterotopic ossification. The development of degenerative changes was graded according to the method of Broberg and Morrey classification system [16]. Heterotopic ossification was classified by using the Brooker's system [17].

In addition, the effects of gender, fracture type, heterotopic ossification, ulnar neuropathy and olecranon osteotomy on the elbow joint range of motion, functional results and time to return to work were investigated.

The financial outcome form was constituted by the authors and the patients asked to complete the form (Table 2). In this form, the patient was asked if he or she was able to return to the same job and position after completing the treatment. After starting to work, being able to continue the former job until the last visit was accepted as a criteria for 'returning to pre-injury work'. In case of returning to the same work, the capacity to do the same work at the same time was asked. In addition, the financial status of the patient during the treatment and after the treatment was questioned.

All statistical analyses were performed using SPSS 13.0 Windows (SPSS Inc. Chicago, IL, USA). Normality of the data was assessed with Shapiro–Wilk test. If continuous data were found to be normally distributed, *T* or ANOVA tests were used according to the group number. If continuous data were found to be non-normally distributed, Mann–Whitney

U or Kruskal Wallis tests were used according to the group number. Chi-squared or Fisher EXACT tests were used for categorical data comparison. *p* value below 0.05 was accepted as statistically significant.

Results

The average age of patients at the time of admission was 38.1 ± 5.4 years (range 19–55) and 36 (75%) patients were male. The mean follow-up time was 39 months (range 12–84 months). The dominant upper extremity was involved in 40 (83.3%) patients. Fifteen (31%) fractures were the result of a working accident, 20 (42%) fractures resulted after falling from a standing height, 7 (15%) fractures resulted after falling from a height (more than 2 m) and 6 (12%) fractures resulted from a motor vehicle accident (Table 1). The mean time from the date of injury to operation was 4 days (range 0–9 days).

The mean elbow flexion was $128^\circ \pm 9^\circ$ (range 100° – 145°). Mean flexion–extension motion arc was $114^\circ \pm 12^\circ$ (range 85° – 135°) and mean flexion contracture was $14^\circ \pm 5^\circ$ (range 5° – 25°). The mean MEPS score was 85 ± 11 (range 65–100); according to MEPS score, the results were graded as excellent for 26 (54%) elbows, good for 15 (31%) elbows and fair for 7 (15%) elbows (Table 3). The flexion arc was more limited in C3 fractures ($p=0.05$) (Table 4) and MEPS was lower in these fractures ($p=0.12$). It was observed that patients with high MEPS could return to their pre-injury work more than the patients with low MEPS ($p=0.04$). The average of MEPS of patients who returned to their pre-injury work was higher than those who could not (89.2 ± 11.2 and 77.5 ± 9.7 , respectively) ($p=0.01$) (Table 5).

Heterotopic ossification was seen in 15 (31%) patients (11 elbows type 1, two elbows type 2 and two elbows type 3) (Table 6). Elbow flexion and flexion arc were more limited in patients with heterotopic ossification ($p=0.02$ and $p=0.04$ respectively) (Table 7). Heterotopic ossification

Table 2 Questionnaire form

Was it an industrial accident?
If it is not an industrial accident, what type was it?
Were you working before the accident?
Were you working before the accident?
Return time to work?
Have you returned back in the same position?
Do you lift load or transport heavy objects at work?
Do you use tool or equipment at work?
Can you do the same or similar work?
Can you do your work at the same time?
Did the ratio of mistake increase at work?
Was it your own job/salaried employment/hourly employment?
How many months did you have medical report?
Annual family income per year?
Who supports the economy of your family?
Did you need government support during your medical report timeline?
Could you receive your salary when you had the medical report?
If you received, did you need extra money?
If you had not received or the money you received were not enough, what was the source?
Did your financial problems affect you psychiatric status?

Table 3 Functional results of patients

Characteristics	Patients (n:48)
Mean elbow flexion (degree)	$128^\circ \pm 9^\circ$ (range 100° – 145°)
Mean elbow flexion contracture (degree)	$14^\circ \pm 5^\circ$ (range 5° – 25°)
Mean elbow flexion–extension arc (degree)	$114^\circ \pm 12^\circ$ (range 85° – 135°)
MEPS	85 ± 11 (range 65–100)
Excellent	26 (54%)
Good	15 (31%)
Fair	7 (15%)

MEPS Mayo Elbow Performance Score

Table 4 Comparison of heterotopic ossification and flexion motion arc among fracture subtypes

	Fracture Type(AO/OTA)			<i>p</i>
	C1	C2	C3	
Heterotopic ossification (patients)	9	2	4	0.02
Flexion arc (degree)	118±7	114±5	98±8	0.05

AO/OTA Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association

Table 5 Factors that affect the return to work

	Return to work		<i>p</i> value
	Yes	No	
Patients, <i>n</i> (%)	38	10	
Fracture type (AO/OTA), <i>n</i> (%)			
C1	24	2	0.03
C2	11	5	
C3	3	3	
Heterotopic ossification, <i>n</i> (%)			
Yes	11	4	0.05
No	28	5	
Olecranon osteotomy, <i>n</i> (%)			
Yes	32	8	0.53
No	6	2	
Manual labor, <i>n</i> (%)			
Yes	34	10	0.77
No	4	0	
Flexion (degree)	126±8.5	120±4.7	0.02
Flexion arc (degree)	113.6±10.6	108±4.8	0.02
MEPS	89.2±11.2	77.5±9.8	<0.01

Bold values denote statistical significance at the $p \leq 0.05$ level

MEPS Mayo Elbow Performance Score, AO/OTA Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association

Table 6 Complications

Complication type	Patients (<i>n</i> :48)
Superficial infection <i>n</i> (%)	4 (8%)
Nonunion <i>n</i> (%)	2 (4%)
Ulnar neuropathy <i>n</i> (%)	4 (8%)
Heterotopic ossification (Brooker's system) <i>n</i> (%)	
Type 1	11(23%)
Type 2	2 (4%)
Type 3	2 (4%)
Degenerative arthritis (Broberg–Morrey classification) <i>n</i> (%)	
Grade 1	8 (17%)
Grade 2	4 (8%)
Grade 3	1 (2%)

occurrence was observed more commonly in less complex fractures interestingly ($p=0.02$) (Table 4). The rate of return to pre-injury work was lower in patients with heterotopic ossification ($p=0.05$) (Table 5). However, it was observed that the development of heterotopic ossification did not affect the returning time to work (6.1 ± 2.7 months, 6.7 ± 2.2 months, respectively) ($p=0.53$).

Degenerative arthrosis was seen in 13 (27%) patients and among these 8 were grade 1, 4 were grade 2 and 1 was grade 3, according to Broberg–Morrey classification (Table 6). Elbow flexion and flexion arc were more limited in patients who developed degenerative changes ($p=0.09$ and $p=0.04$, respectively) (Table 7). However, it was found that the development of osteoarthritis did not significantly affect MEPS ($p=0.49$).

Nonunion was observed in two patients, one (2%) at humeral metaphysis and one (2%) at the olecranon osteotomy side. The patient who had nonunion at the metaphyseal area of the distal humerus was re-operated 4 months after the trauma. The nonunion area was grafted with autologous bone graft, stabilization was achieved with longer plates and the bone union was achieved after 6 months postoperatively. Nonunion in the olecranon osteotomy line was seen in the patient who underwent osteosynthesis with a 6.5 mm cancellous screw. In this patient, the screw was removed, the osteotomy line was cleaned, osteosynthesis was performed using the tension band technique and union was achieved after 6 months postoperatively. Both patients were able to return to their pre-injury work.

Five patients (10%) had early postoperative superficial wound infection managed non-operatively with oral antibiotics and wound care (Table 6).

During the operation, in ten patients the ulnar nerve was transposed anterior due to implant irritation and at the last control none of them had ulnar neuritis signs. At the last control, four of the patients without ulnar nerve transposition had mild ulnar neuritis (McGowan grade 1) [18]. Ulnar sensory neuropathy symptoms did not improve in two patients. In these patients, after completion of the union, the medial plate was removed and the ulnar nerve was released. During the follow-up, patients' complaints improved. The symptoms of the other two patients recovered spontaneously and completely within 3 months after operation. No statistically significant relationship was found between ulnar nerve transposition and flexion arc width and MEPS ($p=0.71$, $p=0.67$ respectively) (Table 7). All of the patients who had ulnar neuritis signs could return to their pre-injury works.

Olecranon osteotomy was applied to 40 of 48 patients. There was no difference between the patients performed olecranon osteotomy and those did not in terms of flexion arc and MEPS ($p=0.90$ and $p=0.65$, respectively). It was also found that olecranon osteotomy did not negatively

Table 7 Factors that affect the functional results

	Flexion (degree)	<i>p</i> value	Flexion arc (degree)	<i>p</i> value	MEPS	<i>p</i> value
Olecranon osteotomy						
Yes	125.3	0.84	112.1	0.90	86.4	0.65
No	126.6		114.1		88.8	
Heterotopic ossification						
Yes	124.2	0.02	111.3	0.04	85.3	0.05
No	125.8		112.5		87.1	
Osteoarthritis						
Yes	124.5	0.09	112	0.08	86.2	0.49
No	126		113.1		87.6	
Ulnar nerve transposition						
Yes	124.6	0.69	112	0.71	85	0.67
No	125.6		115.8		87	

affect the return to work or the time of return ($p=0.53$ and $p=0.83$, respectively) (Table 5).

In our study, all of the patients were considered to be blue collar workers. Blue collar was considered as jobs in entry- or low-level position, manual labor, or requiring no specialized training. The average time to return to work was 6.5 ± 2.4 months (3–12 months). The rate of return to pre-injury work after treatment was higher in women ($p=0.517$). Thirty-eight (79%) patients returned to the same work and 29 (76%) of them started to work at the same position before the fracture occurred. Nine of 38 patients (24%) had to change their positions. Among the 48 patients, 10 patients (21%) could not return to the same job, 7 of them began to work in a lighter job and 3 of them had to be retired. If the injury was the result of a working accident, the average time to return to work was longer ($p=0.08$). The rate of return to the same job was lower for heavy workers ($p=0.38$). All the patients who changed their works and changed their positions were manual laborers. Twenty-nine patients who went back to the same position were manual laborers using instruments. Five of them declared that they had difficulties while working.

Among the 48 patients, 34 (70%) were breadwinners. All of the patients had taken grant in aids during the healing periods from a social security institution (approximately 2/3 of their earnings). Thirty-five (73%) patients needed additional money and 25 of them had taken money.

Discussion

The main goal of the treatment of intra-articular DHF is anatomical reduction of the joint surface and a stable fixation that allows early rehabilitation without failure of fixation. Although good functional results have been reported in the literature for the treatment of DHF with anatomical plates, many complications can be seen in the treatment of these

fractures [19–24]. The most important finding of this present study was that 79% patients with a type C distal humerus fracture who were treated with double plating were able to return to pre-injury work in a mean 6.5 ± 2.4 months (range 3–12).

In this study, the functional results according to MEPS were excellent or good in 85% of the patients. In the studies evaluating the functional results of DHF treated with angular-stable plates, good and excellent results were reported as 92% by Schmidt–Horlohe et al., 86% by Kaiser et al. and 85% by Reising et al. [4, 9, 10]. Wound complications, heterotopic ossification, obesity and ulnar neuropathy are risk factors that may affect functional results negatively [20–23]. One of the most important factors affecting the functional results is elbow range of motion. Morrey reported that gaining between 30 and 130 degrees of joint motion arc is enough to achieve 90% of the daily activities [26]. In their study, Tunali et al. evaluated all of the possible risk factors for stiffness such as fracture type (complexity, open–closed), presence of olecranon osteotomy–postoperative neuropraxia and delayed time from injury to surgery. They concluded that patients had complex fractures and patients who were operated 7 days or more after the injury show more limitation in elbow movements [2]. In our study, the range of motion was more restricted in more complex fractures and MEPS was lower in these fractures similarly. However, it was observed that ulnar neuropathy and presence of olecranon osteotomy did not adversely affect the flexion arc and functional results.

In our study, it was also observed that most of the patients with high MEPS score could return to their pre-traumatic work.

Heterotopic ossification is one of the most important causes of elbow stiffness and decreased range of motion [20]. Sanchez-Sotelo et al. stated that the differences in flexion, extension and the total arc of motion between the

patients with and those without heterotopic ossification were all significantly different ($p < 0.001$) [12]. In our study, the elbow flexion arc was found to be more limited in patients with heterotopic ossification. The ulnar neuropathy has been reported to be 0–15% in the treatment of DHF [9, 12, 24, 28–30]. In the present study, ulnar neuropathy resulting in transient hypoesthesia occurred in four (8%) patients. This rate is consistent with the other reported results [9, 12, 24, 28–30]. In our study, ulnar nerve was routinely identified and protected. The anterior transposition of the ulnar nerve is still a matter of debate. Wang et al. suggested the routine anterior transposition of the ulnar nerve [28]. Shin et al. recommended in their review that the decision to transpose the ulnar nerve may be based in part on the injury type and can be performed when the implants irritated the ulnar nerve [29]. In our operations, after we applied the medial plate, we evaluated whether the medial plate irritated the ulnar nerve during flexion and in the presence of irritation the nerve was transported to the anterior, subcutaneously.

The effects of surgical approach on functional outcomes in the treatment of distal humerus fractures have always been a matter of curiosity [18, 31, 32]. Azboy et al. evaluated the functional outcomes of patients with intra-articular DHF treated with triceps-reflecting anconeus pedicle (TRAP) and olecranon osteotomy and they found that TRAP provides better arc of elbow motion with low complication and reoperation rates [31]. Chen et al. compared the triceps-sparing approach with olecranon osteotomy regarding their effects on the functional outcomes of intercondylar fracture and concluded that there was no difference between the functional results obtained by both methods [32]. In our study, paratricipital approach was used in eight patients who had AO type C1 fractures. Olecranon osteotomy was preferred in the remaining 40 patients and the majority of these patients were AO type C2 and C3 fractures. The effects of olecranon osteotomy on the elbow range of motion and functional results were examined and no statistically significant differences were found.

There are many studies that investigate the outcomes of DHF [4, 5, 7–13]. However, very little attention has been focused on what seems to be a major concern of patients after trauma [6, 33–35]. Still, we have not obtained certain responses for “When can I return back to work? Will my arm be functional as before the injury? Can I do my work as before?”. Patients expect that they will return to pre-morbid activities as soon as possible, but only few patients have made adequate provisions for prolonged time off work. Trauma causes serious financial problems for patients, especially blue collar workers [33]. In our country, employees receive social security benefits at the rate of 2/3 of their earnings during recovery. These patients do not have the financial reserves to withstand not having an income for several months. Distal humerus fractures prevent the patients

from returning to work for several months. Because of this issue, most patients try to solve the financial problems with alternative methods. In our study population, 35 (73%) patients were breadwinners. For this group, loss of the 1/3 monthly earning is a big financial problem. This financial impact is important not only to the patients, but also to those close to them. The relied-upon source for fulfilling financial obligations post-injury was reported as family and friends, with 71% of patients using them as a source.

In our study, ten (21%) patients could not return to the same job and nine (19%) of the patients who returned back to work had to change their positions. The return of patients to their work may not always be an appropriate parameter in measuring the outcomes of a treatment or evaluating its effectiveness. This process can be affected by many factors such as the patient’s health status, psychological problems, his/her job and medico-legal issues. Many studies in the literature have shown that psychosocial factors are the most important factors that affect returning back to work, especially in patients with chronic musculoskeletal pain [30–32]. In addition, patients may experience physical, emotional and mental exhaustion throughout their working life. This exhaustion can affect both patients’ recovery process and motivation to return to work. People who are happy at work, who are more satisfied with their work and have good relationships with their coworkers may return to work earlier. The work accidents and traffic accidents also cause expectation of compensation in patients, which can increase the patient’s returning to working period. In our patients group, both psychosocial factors and expectation of compensation may have affected patients’ returning time to their works. However, the fact that the judicial processes in our country are very long and that many of the patients in the study group are the only people who make money at home have taken us away from this idea. At the final controls, the patients who could not return to their works stated that they wanted to start working, but the work they did was heavy and the condition of their elbows was not sufficient to do this work.

Our study has several limitations. First of all, it is a retrospective study. A second limitation is the small number of patients which makes it difficult to draw clear conclusions. The results should be verified in a larger population. Another important limitation was absence of the control group consisting of white collars. This group would allow us to compare the level of education of the patient and the effects of light work on returning to work. The range of supination and pronation motions was not evaluated as osteotomy of the olecranon might affect it. In the literature, this is the first study which investigated whether patients with DHF can return to their pre-injury work after the treatment.

As a conclusion, AO-type C2 and C3 fractures and heterotopic ossification had negative effects on elbow flexion arc

and functional results. These factors also adversely affected the patients' returning to their pre-injury works. It was also determined that olecranon osteotomy, ulnar nerve transposition or neuropathy and degenerative arthrosis are not risk factors for functional outcomes. When the results were evaluated, it was observed that the study hypothesis was confirmed. Although the functional results of surgical treatment of intra-articular distal humerus fractures seem to be good, at the end of the treatment, especially heavy workers may have difficulties in returning to their pre-injury works.

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Compliance with Ethical Standards

Conflict of Interest All authors declare that they have no conflict of interest.

Ethical Standard Statement This article does not contain any studies with human or animal subjects performed by any of the authors.

Informed Consent For this type of study informed consent is not required.

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