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Natural History of Patients with Acute Proximal Biceps Tendon Rupture

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SUMMARY

Purpose. To determine the natural history of patients presenting with acute proximal biceps rupture (APBR) and concomitant rotator cuff disease.

Methods. Prospective cohort study of patients with an APBR confirmed via magnetic resonance imaging (MRI) presenting to clinic within 8 weeks of injury. Visual Analog Scale (VAS) pain score, Simple Shoulder Test (SST) score, and the American Shoulder and Elbow Surgeons (ASES) score were the main outcome measures assessed at a minimum of two-years.

Results. Twenty-seven patients were included in the final analysis: seven females (26%) and 20 males (74%) (mean age: 61 years, range 42-78 years). Rotator cuff tears were found in 25 patients (93%). At two-year follow-up (SD 0.28), nine patients (33%) without improvement or dis-satisfaction with conservative management opted to undergo shoulder surgery (all with rotator cuff tears), at a mean 4.5 months (range 1.2-24 months) after injury. Worker's Compensation and a history of diabetes were significantly associated with having surgery. At the two-year follow-up, the median patient reported outcomes (PROs) were as follows: VAS pain- 0.0 (IQR 0.0-3.0); Disability subscale- 48.3 (IQR 34.2-50.0); ASES total- 89.2 (IQR 70.0-98.3); and SST- 11.0 (IQR 9.0-12.0). There was no statistically significant difference in PROs between patients who went on to have surgery and those who did not.

Conclusions. Satisfactory PROs and low levels of pain were reported at the two-year follow-up in patients with an APBR, with no difference between those patients who underwent surgical intervention and those who did not.

KEY WORDS

Acute proximal biceps tendon; magnetic resonance imaging; observational study; rotator cuff pathology; shoulder; shoulder injuries.

BACKGROUND

The unique anatomy and biomechanics of the proximal long head biceps tendon (LHBT) place it at high risk for injury (1-5). Repetitive friction, traction and glenohumeral rotation, with subsequent pressure and shear forces at specific, anatomically constricted locations may account for its susceptibility to rupture (3, 6) (**figure 1**). Still, despite extensive research on the long head of the biceps tendon, controversy persists in regards to its function as well as operative and non-operative management of injury (7-9).

Acute proximal biceps rupture (APBR), presenting in isolation in a less physically demanding patient, can be treated successfully with benign neglect (10, 11). However, only recently has literature demonstrated a high prevalence of rotator cuff pathology in patients presenting with a chief complaint of APBR (**figure 2**). Kowalczuk *et al.* (12) reported an 85% prevalence of concomitant rotator cuff tear in the setting of APBR, while the current authors similarly found a 93% prevalence of rotator cuff pathology with approximately 50% of patients having a full thickness rotator cuff

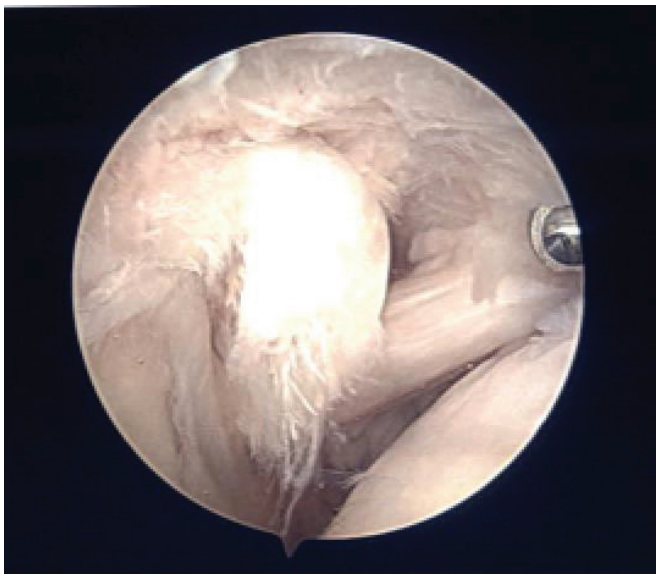

Figure 1. Intraoperative arthroscopic photo of a right shoulder in the beach chair position demonstrating a biceps tendon rupture.

tear (13). As this data suggests that APBR may be a harbinger of concurrent rotator cuff disease, Kowalczuk *et al.* recommends that clinicians be hypervigilant when presented with an APBR; however, the literature is sparse and the clinical course and outcomes after APBR with associated rotator cuff pathology is poorly understood.

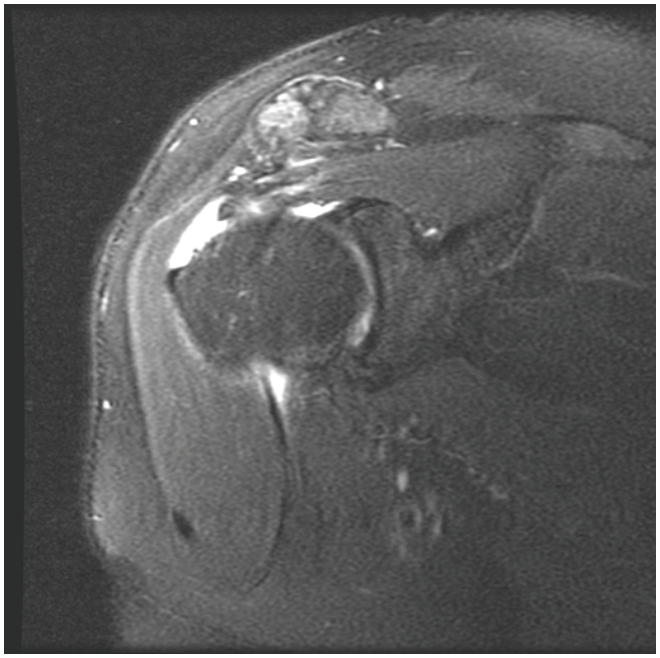

Figure 2. Coronal magnetic resonance image of a right shoulder demonstrating a full-thickness rotator cuff tear.

The purpose of this study is to determine the natural history and outcomes of patients presenting with APBR. Our hypothesis was that the majority of patients with APBR would present with concurrent rotator cuff disease, but demonstrate low levels of pain and high patient reported outcome scores regardless of treatment. We also hypothesized that overall low proportion of patients would choose to undergo surgical intervention after failing conservative management strategies.

MATERIALS AND METHODS

After institutional review board approval, International Classification of Diseases codes (ICD-9) were used to prospectively collect data on 42 consecutive patients from five treating surgeons between September 2015 and February 2017. Patients 18 years or older with a diagnosis of an APBR were included. Acute, injury was defined as presenting to clinic within eight weeks of injury. Patients with a history of ipsilateral shoulder surgery were excluded, as were patients unable to undergo magnetic resonance imaging (MRI) due to contraindications. Patients with incomplete medical records were also excluded. A total of 15 patients were excluded: seven patients were excluded due to previous ipsilateral shoulder surgery, three patients were not seen within the eight-week window deadline, two patients did not have the correct diagnosis, two patients declined participation, and one patient's Worker's Compensation would not allow participation.

Demographics such age, sex, body mass index (BMI), hand dominance, diabetes, tobacco use, Worker's Compensation for the injured shoulder, and mechanism of injury were obtained. Patients underwent routine physical examination and plain radiography as part of their initial assessment. MRI was obtained to confirm the diagnosis of APBR, as well as to allow assessment of the rotator cuff. MRIs were interpreted by a Shoulder/Elbow or Sports Medicine Fellowship-trained orthopedic surgeon. The rotator cuff was recorded as the presence or absence of tearing, and if disrupted, to what degree (full or partial thickness tearing). A subset analysis was performed specifically for the subscapularis tendon.

Primary outcome variables included Visual Analog Scale (VAS) pain score, Simple Shoulder Test (SST) score, and the American Shoulder and Elbow Surgeons (ASES) score. Additional outcome variables included whether or not the patient underwent ipsilateral shoulder surgery for any reason, and risk factors for surgery. Outcomes were noted with a minimum follow-up of two-years. This study meets the ethical standards of the journal (14).

All data underwent descriptive statistical analysis using SAS version 9.4 (SAS Institute, Cary, NC; http://www.sas.com/software/sas9). Two groups were defined based on the severity of rotator cuff tear for comparative analysis. A Wilcoxon rank sum test was used for non-parametric continuous variables. A two-sample t test was used for normally distributed data. For categorical variables, a chi-square test (or Fisher's exact test, where appropriate) was used for comparisons between groups. Significance was determined by an alpha level of 0.05. Study data was collected and managed using REDCap electronic data capture tools hosted at OrthoCarolina Research Institute (15).

RESULTS

Twenty-seven patients met the inclusion criteria and were included in the final analysis. The median time from injury to clinical evaluation was 21 days (interquartile range, IQR: 9 days, 37 days). There were seven females (26%) and 20 males (74%), with an average age of 61 years (SD: 10; range 42-78 years). The dominant extremity was affected in 20 shoulders (74%), while 11 patients reported antecedent shoulder pain (41%). Additional demographic data can be found in **table I**.

Rotator cuff tears were found in 25 of the 27 patients (93%). Full thickness tears (N = 13; 52%) and partial thickness tears (N = 12; 48%) were seen in almost equal amounts. Seven patients had subscapularis tears in isolation, which were included in the "rotator cuff tear" group (**table II**).

When stratified by rotator cuff tear, there was no significant difference between the full thickness and partial thickness tear groups in regard to gender, age, dominant extremity, diabetes or other demographic data and injury variables (**table III**).

By the mean 2.2-year follow-up (SD 0.28, range 1.83-2.75 years), nine patients had undergone ipsilateral shoulder surgery (33%), at a mean time of 4.5 months from injury (range 1.2- 24 months). Seven surgeries were arthroscopic, while two patients underwent reverse shoulder arthroplasty. The seven arthroscopic surgeries included: four rotator cuff repairs, one rotator cuff repair with biceps stump debridement, and two biceps stump debridement, subacromial decompressions, and distal clavicle excisions. The two reverse shoulder arthroplasties were performed for irreparable massive rotator cuff tears (**table IV**). Worker's Compensation status and a history of diabetes were significantly associated with having surgery, compared to those who did not have surgery (**table V**).

Patient reported outcomes (PROs) were available on 27 patients at initial presentation to our clinic. The median overall PROs at initial examination were as follows: VAS pain 4 (IQR 1.6-6); disability subscale: 33.3 (IQR 15-43.3); ASES total: 66.7 (IQR 41.7-80.7); and SST: 8 (IQR 3-11).

Table I. Patient demographic data (N = 27).

Demographic data for patients meeting inclusion criteria	
Sex, n (%)	
Male	20 (74.1%)
Female	7 (25.9%)
Age (years), mean (SD)	60.6 (9.9)
BMI (kg/m^2), mean (SD)	28.9 (5)
Dominant Side Injury, n (%)	20 (74.1%)
Diabetes, n (%)	4 (14.8%)
Tobacco Use, n (%)	
Never	15 (55.6%)
Past	11 (40.7%)
Currently	1 (3.7%)
Contralateral Shoulder Surgery, n (%)	4 (14.8%)
Antecedent Shoulder Pain, n (%)	11 (40.7%)
Worker's Compensation, n (%)	4 (14.8%)
Mechanism of Injury, n (%)	
Trauma	24 (88.9%)
Overuse	3 (11.1%)

BMI: Body Mass Index; SD: Standard Deviation.

Table II. MRI details (N = 27).

MRI Variable	N (%)
Rotator Cuff Tear	
No	2 (7.4%)
Yes	25 (92.6%)
Full Thickness Tear	13 (52.0%)
Partial Tear	12 (48.0%)
Subscapularis Tear	
No	20 (74.1%)
Partial	6 (22.2%)
Full	1 (3.7%)

When stratified by patients managed by surgical or non-operative treatment, at initial presentation the patients treated non-operatively had significantly better PROs scores in: Disability subscale (P-value = 0.002), ASES total (P-value = 0.01), and SST (P-value = 0.006) (**table VI**). Although not statistically significant, VAS pain score at initial exam was lower in patients managed non-operatively.

PROs were available on 22 patients (full thickness: N = 10, partial thickness: N = 10, no tears: N = 2) at mean 2.2-year follow up. The median overall PROs scores were as follows: VAS pain: 0.0 (IQR 0.0-3.0); disability subscale: 48.3 (IQR 34.2-50.0); ASES total: 89.2 (IQR 70.0-98.3); and SST: 11.0 (IQR 9.0-12.0). There was no statistically significant difference

Table III. Demographics and injury variables (stratified by rotator cuff status (N = 27)).

Demographics and Injury Variables	Full Thickness Tear (N = 13)	Partial Tear (N = 12)	P-value†	No Tear (N = 2)
Sex, n (%)			**0.378**	
Male	8 (61.5%)	10 (83.3%)		2 (100%)
Female	5 (38.5%)	2 (16.7%)		0 (0%)
Age (years), mean (SD)	64 (9)	57.6 (10.5)	**0.115**	57 (8.5)
BMI (kg/m^2), mean (SD)	27.9 (4.5)	30 (5.8)	**0.328**	28.5 (1.5)
Dominant Side Injury, n (%)	8 (61.5%)	11 (91.7%)	**0.160**	1 (50%)
Diabetes, n (%)	3 (23.1%)	1 (8.3%)	**0.593**	0 (0%)
Tobacco Use, n (%)			**0.999**	
Never	7 (53.8%)	6 (50.0%)		2 (100%)
Past	6 (46.2%)	5 (41.7%)		0 (0%)
Currently	0 (0%)	1 (8.3%)		0 (0%)
Contralateral Shoulder Surgery, n (%)	1 (7.7%)	2 (16.7%)	**0.593**	1 (50%)
Antecedent Shoulder Pain, n (%)	7 (53.8%)	2 (16.7%)	**0.097**	2 (100%)
Worker's Compensation, n (%)	1 (7.7%)	3 (25.0%)	**0.322**	0 (0%)
Mechanism of Injury, n (%)			**0.999**	
Trauma	11 (84.6%)	11 (91.7%)		2 (100%)
Overuse	2 (15.4%)	1 (8.3%)		0 (0%)

BMI: Body Mass Index; SD: standard deviation. †Statistical significance tests were performed to look at differences between the Full Thickness Tear group and the Partial Tear group. The No Tear group was not included in the statistical test. Chi-square or fisher's exact tests were used for categorical data and t-tests were used for continuous normally distributed data to determine statistical significance between groups at an alpha level of 0.05.

Table IV. Surgery data (N = 9).

Group Study ID	Procedure	Time from Injury to Surgery
Full Thickness Tear (N = 6)		
01	RCR, SAD	1.2 months
05	RCR, SAD, debridement of biceps tendon stump	2.8 months
06	Reverse total shoulder arthroplasty	24 months
13	RCR, SAD	1.4 months
27	Reverse total shoulder arthroplasty, latissimus tendon and teres major tendon transfer	1.4 months
29	RCR, SAD	3.3 months
Partial Thickness Tear (N = 3)		
08	SAD, DCE, capsular release, debridement of biceps tendon stump	1.8 months
10	SAD, DCE, biceps tenodesis	1.6 months
11	RCR, SAD	3.2 months

RCR: rotator cuff repair; SAD: subacromial decompression; DCE: distal clavicle excision

Table V. Risk factor analysis for surgery (N = 27).

Demographics and Injury Variables	Had Surgery		P-value†
	No (N = 18)	Yes (N = 9)	
Sex, n (%)			0.999
Male	13 (72.2%)	7 (77.8%)	
Female	5 (27.8%)	2 (22.2%)	
Age (years), mean (SD)	60.3 (11.3)	61.3 (6.7)	0.799
BMI (kg/m²) , mean (SD)	28.1 (4.9)	30.6 (4.9)	0.220
Dominant Side Injury, n (%)	13 (72.2%)	7 (77.8%)	0.999
Diabetes, n (%)	0 (0%)	4 (44.4%)	0.007
Tobacco Use, n (%)			0.999
Never	10 (55.6%)	5 (55.6%)	
Past	7 (38.9%)	4 (44.4%)	
Currently	1 (5.6%)	0 (0%)	
Contralateral Shoulder Surgery, n (%)	1 (5.6%)	3 (33.3%)	0.093
Antecedent Shoulder Pain, n (%)	9 (50.0%)	2 (22.2%)	0.231
Worker's Compensation, n (%)	0 (0%)	4 (44.4%)	0.007
Mechanism of Injury, n (%)			0.250
Trauma	17 (94.4%)	7 (77.8%)	
Overuse	1 (5.6%)	2 (22.2%)	
Rotator Cuff Tear, n (%)			0.411
Full Thickness Tear	7 (38.9%)	6 (66.7%)	
Partial Tear	9 (50.0%)	3 (33.3%)	
No Tear	2 (11.1%)	0 (0%)	

BMI: Body mass Index; SD: standard deviation. †Chi-square or fisher's exact tests were used for categorical data and t-tests were used for continuous normally distributed data to determine statistical significance between groups at an alpha level of 0.05.

Table VI. Patient reported outcomes at initial exam and at 2 year follow-up (stratified by surgical status).

	Surgery			
	Overall	No	Yes	P-value
At Initial Exam (N = 27)				
VAS Pain, median (IQR)	4 (1.6, 6)	2.6 (1, 4.7)	4 (4, 6.3)	**0.127**
ASES - Function/Disability Subscale, median (IQR)	33.3 (15, 43.3)	40 (33.3, 45)	15 (11.7, 23.3)	**0.002**
ASES - Total, median (IQR)	66.7 (41.7, 80.7)	78.5 (59.8, 88.3)	43 (33.5, 51.7)	**0.010**
Simple Shoulder Test, median (IQR)	8 (3, 11)	9.5 (6, 12)	1 (1, 5)	**0.006**
At 2 yrs post MRI (N = 22)				
VAS Pain, median (IQR)	0.0 (0.0, 3)	0.0 (0.0, 3)	0.0 (0.0, 5)	**0.817**
ASES - Function/Disability Subscale, median (IQR)	48.3 (34.2, 50)	48.3 (31.7, 50)	45 (36.7, 50)	**0.966**
ASES - Total, median (IQR)	89.2 (70, 98.3)	89.2 (70, 98.3)	92.5 (71.7, 100)	**0.757**
Simple Shoulder Test, median (IQR)	11 (9, 12)	11 (7, 12)	11 (9, 12)	**0.903**

Table VII. Patient reported outcomes at 2‡ year follow-up (overall and stratified by rotator cuff status).

	Stratified by Group				
N; Median (IQR)	**Full Thickness Tear (N = 10)**	**Partial Tear (N = 10)**	**P-value†**	**No Tear (N = 2)***	**Overall (N = 22)**
ASES (Patient)					
VAS Pain (0-10)	10; 0.0 (0.0, 2.5)	10; 1.8 (0.0, 4.0)	**0.429**	2; 0.0 (0.0, 0.0)	22; 0.0 (0.0, 3.0)
Function/ Disability Subscale	9; 48.3 (31.7, 50.0)	9; 41.7 (38.3, 48.3)	**0.999**	2; 49.2 (48.3, 50.0)	20; 48.3 (34.2, 50.0)
ASES Total	8; 91.7 (78.3, 99.2)	9; 85.0 (68.3, 98.3)	**0.539**	2; 99.2 (98.3, 100)	19; 89.2 (70.0, 98.3)
Simple Shoulder Test	10; 10.5 (7.0, 12.0)	9; 10.0 (9.0, 12.0)	**0.999**	2; 12.0 (12.0, 12.0)	21; 11.0 (9.0, 12.0)

IQR: Interquartile Range; ASES: American Shoulder and Elbow Surgeons score; VAS: Visual Analogue Scale. ‡Time from injury to PRO: mean 2.2 years (SD: 0.28 years); range 1.83-2.75 years. †Statistical significance tests were performed to look at differences between the Full Thickness Tear group and the Partial Tear group. The No Tear group was not included in the statistical test. Wilcoxon rank-sum tests were used for continuous non-normally distributed data to determine statistical significance between groups at an alpha level of 0.05. IQR- interquartile range. *Note: the IQR is also the range for this group.

in PROs between the full thickness and partial thickness tear groups (**table VII**). Furthermore, at mean 2.2-year follow up, there was no statistically significant difference in PROs between patients who went on to have surgery and those who did not.

DISCUSSION

There is ample literature highlighting patients with rotator cuff tears with concurrent proximal long head biceps tendon pathology (16-19). It has been theorized that adjacent rotator cuff inflammation can lead to secondary biceps tenosynovitis, while subscapularis tears or rotator interval lesions could result in LHBT instability and subsequent tearing (20-22). However, only recently has the literature reported the converse relationship: patients presenting with APBR with concomitant rotator cuff disease (12, 13). Furthermore, to our knowledge there is a lack of literature characterizing the natural progression of this specific population.

In this prospective cohort study, nine patients (33%) had undergone ipsilateral shoulder surgery, at a mean time of 4.5 months from injury. In Kuhn *et al.*'s study of 319 patients with attempt at conservative treatment for rotator cuff tears, 82 patients eventually had surgery (26%), with most patients doing so within 12 weeks (23). Our study found that Worker's Compensation status and a history of diabetes were significantly associated with having surgery. Kweon *et al.* observed younger age and lower BMI were predictive of eventual allocation to surgical treatment in the management of rotator cuff tears (although they did not specifically analyze the variables of Worker's compensation and history of diabetes) (24). There is evidence showing a relationship between thyroid disease non-traumatic rotator cuff tears in females independent of age (25). We did not study the relationship between thyroid pathologies and outcomes in our study population. However, future studies may benefit by investigating if thyroid disorder in a similar cohort of patients to our study is a risk factor for poorer outcomes or predictive of failing conservative treatment and requiring surgery. There currently is no literature on the timeline of conservative treatment of acute proximal biceps ruptures that failed and were allocated to surgical management.

Patients who were treated non-operatively had significantly better PROs in disability subscale, ASES total, and SST at initial clinical presentation. Furthermore, the patients treated non-operatively had lower levels of pain, albeit statistical analysis did not show significance. Indications for surgery included failure to respond or patient dis-satisfaction with conservative treatment entailing physical therapy, non-steroidals, and activity modifications. Of note, all nine patients that underwent surgical intervention had APBR with associated rotator cuff tears. The mean time of 4.5 months from injury to surgical intervention in our study is in accordance with Oliva *et al.*'s recommendations for treatment of long head of the biceps condition in association with lesions of the rotator cuff. The aforementioned guidelines recommend surgical exploration and possible treatment if symptoms persist for more than 3 months after conservative treatment (26). Lower scores in PROs are equivalent to a greater limitation in shoulder functioning and likely negatively affects patient's motivation and willingness to continue conservative management. As a result, patients may have a lower threshold to seeking surgical treatment.

Our data reveals low levels of pain (VAS median-0.0, IQR 0.0-3.0) and satisfactory PROs (ASES median-89.2, IQR 70.0-98.3; SST median-11.0, IQR 9.0-12.0) at the two-year follow-up, with no difference between patients who went on to have surgery and those who did not. Kim *et al.* (27),

Koh *et al.* (28), Lee *et al.* (29) found similar outcomes in their studies of rotator cuff repairs with concurrent biceps pathology: SST 9.3 ± 1.6 and ASES 88.6 ± 8.9, ASES 79.6 ± 15.8, and VAS 2.0 and ASES 82.8, respectively.

We recognize several limitations to our study. It is well known that there is a high incidence of rotator cuff pathology in patients older than 60 years of age. As the average age of our cohort was 61 years, there is potential for confounding bias in our study. Also, each MRI was reviewed by one surgeon, with multiple surgeons (N = 5) included in the study. Intra-observer and inter-observer reliability would increase the validity of our study. However, all reviewers were shoulder/elbow or pports medicine fellowship-trained orthopedic surgeons. Lastly, as the overall sample size is small, it may not be large enough to detect differences between groups. Finally, there was heterogeneity with regard to surgical interventions for the nine patients. Seven patients underwent arthroscopic procedures with two patients receiving reverse shoulder arthroplasty. This may be due to the heterogeneous demographical characteristics of our study population and demonstrates that an individualized patient-centered care approach to this population yielded comparable outcomes at the two-year follow-up in patients with conservative or surgical management.

CONCLUSIONS

This is the first study, to our knowledge, to elucidate on the natural history and outcomes of acute proximal biceps ruptures. In this prospective, observational cohort, 93% of patients presented with concomitant rotator cuff tears, with 1/3 of patients eventually having surgery. However, low levels of pain and satisfactory PROs were reported at the two-year follow-up, with no difference between those who eventually had surgery and those who did not. These findings allow clinicians to have prognostic discussions with patients presenting with APBR.

CONFLICT OF INTERESTS

The authors declare that they have no conflict of interests.

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