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Treatment Results of Bicondylar Tibial Fractures Using Hybrid External Fixator

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Abstract: Tibial condyle fractures affect knee stability and motion. Treatment of bicondylar type of tibial plateau fracture is a challenging problem. This study aimed at evaluating the application of hybrid external fixators with minimum deformation in these patients and the resulted outcomes. In this descriptive analytical study, 28 patients with bicondylar tibial plateau fractures treated by HEF device were evaluated. The surgeon used a semicircular and one circular wire instead of the one or two loop of conventional HEF device for a better range of motion of the knee joint. Treatment outcomes including quality of walking, union condition, knee range of motion, complications and the final outcome according to the knee score (rusmussen) were checked. Twenty-eight male patients, with the mean age of 40.54±13.83 years were enrolled in the study. Complications occurred in 8 (28.6%) patients; 7 cases with superficial infection and 1 patient with deep vein thrombosis. All complications were managed medically with no significant consequences left. All the patients were able to walk with no aid except in one case. In 96.4% and 89.3% of the cases, the clinical and radiological outcomes were good to excellent, respectively according to the knee score. In 85.7% of the patients, the knee range of motion was in normal limits. Application of hybrid external fixator using one and half ring instead of one or two fixator rings in treating bicondylar tibial fractures was associated with desired clinical and radiological results.

Key words: Tibial condyle fracture, hybrid external fixator, tibial plateau fracture, complication

INTRODUCTION

Bicondylar high-energy fractures are associated with severe articular depression, separation of both condyles, diaphyseal comminution and dissociation and loss of integrity of the soft-tissue envelope (Ali *et al.*, 2003; Goldust *et al.*, 2013a; Lotti *et al.*, 2013). They occur primarily in younger patients usually with multiple injuries. They comprise a diverse group of injuries to a major weight-bearing joint and are frequently associated with functional impairment (Goldust *et al.*, 2013b; Krupp *et al.*, 2009; Mohebbipour *et al.*, 2012). They are regarded as serious and severe injuries because they affect one of the big weight-bearing joints, i.e. knee. It can lead to knee functional disorder if not treated correctly (Fang *et al.*, 2012; Goldust *et al.*, 2013c; Vafae *et al.*, 2012). Bicondylar fractures are less common but are more difficult to treat due to the complexity of the fracture configuration and the associated soft tissue injury. They are associated with a higher complication rate after internal fixation. Common and normal treatment methods such as open reduction and fractures fixation are associated with dangerous complications including infection, non-improvement of injury, disunion, losing

articular movement capability and even amputation (Laible *et al.*, 2012; Milan *et al.*, 2011; Sadighi *et al.*, 2011; Zeng *et al.*, 2011). Hybrid external fixator with/without open reduction and limited fixation of fracture using screws is one of the methods recently suggested to treat these fractures (Crist *et al.*, 2011; Goldust *et al.*, 2012; Vafae *et al.*, 2012). In this method, internal instruments used to be placed in the fractured area as well as damage of the soft tissue resulting from surgery is minimal (Goldust *et al.*, 2013d; Sadighi *et al.*, 2011; Suksathien and Suksathien, 2011). Therefore, it is associated with joint stability, strong fixation, establishment of limb natural axis and preventing its side effects and can be regarded as an ideal method. Different studies have reported good to excellent results in 70-85% of cases used this method (Dailey *et al.*, 2012; Golfurushan *et al.*, 2011; Mauffrey *et al.*, 2011; Sadeghpour *et al.*, 2011). Considering importance and frequency of tibial condylar fractures and important effects of the surgical treatment method on the patients' future, this study decided to evaluate application of hybrid external fixators with minimum deformation in these patients and the resulted outcomes.

MATERIALS AND METHODS

The descriptive analytical study was conducted on 28 patients suffered from tibial bi-condylar fractures and referred to orthopedics ward of Tabriz Shohada hospital from March 2011 to March 2012. Older than 80 years patients, younger than 18 years with open epiphysis cases, subjects with history of ischemic damage of lower extremities, diabetic patients and patients who were not able to walk without other's help for any reason were excluded from the study. Sufficient information was provided for all patients considering kind of surgery, type of study and possible complications. Then, written satisfaction letters were obtained from the patients. All patients were treated using hybrid external fixator. In this method, one and half ring was used instead of one or two complete hybrid external fixating rings to increase the joint motion range and provide conditions required to early surgery due to wide open fractured area and prevent from increasing the soft tissue and bone damages. In this method, a complete ring was placed at a 5-10 cm distance of the joint and a half ring at a 2.5-3 cm distance of the knee joint. The method was used for the first time. To follow-up, the patients referred to clinic after surgery and required graphy was prepared to evaluate union rate of the fracture. The patients' knees were examined and evaluated considering Rasmussen clinical criteria including articular stability, pain, walking capability with/without auxiliary equipments, extension rate of the knee, motion range of the knee and Rasmussen radiological criteria such as knee joint depression, condyle wideness, varus and valgus of the joint. Additionally, primary outcomes, i.e., acute infection, knee motional limit, failure in fracture fixation, failure in fracture reduction and secondary outcomes including delayed infection, motional limit of knee joint, knee instability and osteoarthritis. The resulted outcomes were registered in a pre-prepared questionnaire, evaluated according to Rasmussen knee score system and reported as qualitative and quantitative data. Other variables including age, gender, time interval between fracture and surgery, duration of using fixator, follow-up period duration, type of fracture and fracture direction.

Data analysis: The obtained data was analyzed using SPSS-16 statistical software and stated as Mean± standard deviation, frequency and percentage. Spearman's RHO test was used to evaluate correlation found between clinical and radiological scores and the patients' age. In this study, $p < 0.05$ was regarded statistically meaningful.

RESULTS

In this study, 28 male patients with tibial condylar fracture were evaluated. Mean age of the patients was 40.54 ± 13.83 with 21-70 years range. The understudy patients suffered from type V and VI fractures. Frequency distribution of the study cases and the outcomes resulted according to fracture type have been demonstrated in Table 1. The minimum pre-operation time was one day and the maximum was 21 days. Also, the minimum time of fixator placement was 12 and the maximum was 17 weeks. Average clinical scores were 28.80 ± 1.62 and 26.44 ± 2.20 in fractures type V and VI with 21 as the least and 30 as the highest one. Average radiological scores were 16.80 ± 2.53 and 15.78 ± 2.90 in fractures type V and VI with 10 and 18 as the least and highest ones, respectively. Average follow-up period was 10.82 ± 1.49 months with 9 as the least and 12 as the highest one. Open reduction and fixation using screws were conducted for 20 patients due to undesirable reduction using ligamentotaxis. The results were radiologically excellent, good and relative respectively in 18, 7 and 3 cases. Also, post-operative complications were seen in 8 patients including 7 cases of superficial infection and 1 case of deep vein thrombosis. It should be mentioned that all the above-mentioned cases responded to medical treatments and they had not any undesirable result on the surgical outcomes. Disunion or mal-union was not observed in any patients follow-up period. There was not articular instability and malformation of extremities in the any patients. Articular surface during the was uniform in all cases. At the end of follow-up period, only one patient felt pain while walking and used stick. Other patients walked without using any auxiliary instruments. The patients were evaluated considering correlation between clinical and

Table 1: Evaluation based on fracture type (V and VI)

Label	Type V	Type VI	Total	P
Number (person and percent)	10 (35.7%)	18 (64.3%)	28	
Open fracture (person and percent)	10 (10%)	8 (44.4%)	9	
Closed fracture (person and percent)	9 (90%)	10 (55.6%)	19	
Age (year)	33.30 ± 5.12	44.56 ± 15.56		<0.001
Pre-operation time (day)	4.70 ± 1.25	8.22 ± 6.14		<0.001
Fixator placement duration (week)	13.8 ± 1.55	13.94 ± 1.79		0.86
Follow-up period (month)	10.20 ± 1.55	11.17 ± 1.38		0.68
Clinical score	28.80 ± 1.62	26.44 ± 2.20		<0.01
Radiological score	16.80 ± 2.53	15.78 ± 2.90		0.36

Table 2: Evaluation based on fracture type (open and closed)

Label	Open	Closed	Total	p-value
Number (person and percent)	9 (32.14%)	19 (67.86%)	28 (100%)	>0.05
Age (year)	38.22±9.65	41.63±15.54		>0.05
Pre-operation time (day)	9.00±7.76	6.00±3.32		>0.05
Fixator placement duration (week)	14.11±1.69	13.79±1.72		>0.05
Follow-up period (month)	11.33±1.32	10.58±1.54		0.79
Clinical score	37.11±2.47	27.37±2.27		0.64
Radiological score	15.78±2.91	16.32±2.77		0.82
The resulted outcomes based on radiological criteria				
Excellent	5 (55.6%)	13 (68.4%)		
Good	3 (33.3%)	4 (21.1%)		1.00
Relative 1	(11.1%)	2 (10.5%)		

radiological score. The resulted correlation was weak but meaningful ($p = 0.04$). There was a medium negative but meaningful correlation between clinical score and patients' age ($p = 0.01$). There was not any meaningful correlation between radiological score and age of the understudy patients ($p = 0.68$). The patients were studied considering type of fracture (V, VI). Meanwhile, evaluating the patients considering clinical criteria in the group with type V fracture indicated to excellent result in 9 (90%) and good one in one (10%) cases. Evaluating the patients considering radiologic criteria in the group with type V fracture indicated to excellent result in 8 (80%), good in 1 (10%) and relative in one (10%) cases. In The patients were also evaluated considering types of fracture (open and closed). The results can be found in Table 2.

DISCUSSION

In this study, one and half ring was used instead of one or two common hybrid external fixator rings. In fact, the complete ring is displaced toward the limbs distal. A half ring is placed in the limb proximal to increase motion range of the joint while treating the problem. Using hybrid external fixator made early surgery possible due to widely opening the fractured area as well as preventing from increasing of soft tissue and bone damages (Li *et al.*, 2011). The obtained results indicated to post-operative complications in 8 patients (28.6%) consisting of 7 cases of superficial infections and one case of deep vein thrombosis. All complications were removed following medical treatments. There was not any sign of disunion, articular instability, extremity malformation and lack of articular surface uniformity. Several studies have evaluated complications of these kinds of fractures and how to treat them: In a previous study that evaluated 17 patients suffering from tibial plateau treated using hybrid external fixator and in contrast to our study reported delayed union and infection in 32.5 and 47% of the patients (Raikin and Froimson, 1999). In contrast to

our study, in their study on 20 patients (Ali *et al.*, 2003), indicated to lack of any disunion. They demonstrated that there was superficial infection in 35% and deep vein thrombosis in 5% of the cases. Also, surgery was repeated in 25% of the cases. In contrast to our study, in a previous research, authors studied 25 patients and reported articular malformation and infection in 4% of the cases (Katsenis *et al.*, 2005). The reported complications vary across different studies. In the present study, incidence of the complications is in an acceptable range with mild complications. But, there are higher rate of superficial infections in comparison with other studies. Meanwhile, in a previous study, authors suggested using stricter aseptic methods during and after operation, increasing post-operative cares, quickly treating with antibiotic and debrideman, if required (Hutson and Zych, 1998). In this study, the patients' knee function was evaluated during and after follow-up period. For this purpose, Rasmussen knee score system was used. Qualitative and quantitative evaluation and better comparison with other studies are of advantages of the mentioned system. In the present study and considering two V and VI types of fracture, mean clinical and radiological score of the patients were estimated as 27.29 ± 2.90 and 16.14 ± 2.77 , respectively. Considering mean clinical and radiological score of all understudy patients, final outcomes demonstrated that excellent, good and relative results were obtained in 66.1, 26.8 and 7.2% of the cases, respectively. Only one patient walked with the help of stick and motion range of the affected knee joint was normal in 85.7%. In contrast to our study, in a previous research authors studied 35 patients and reported good to excellent results in 85.7%, relative ones in 5.7 and weak results in 8.6% of the cases (Aggarwal and Nagi, 2006). In accordance to our study, in the study conducted previously, good to excellent results were reported in 76% of the clinical and 81% of the radiological findings (Katsenis *et al.*, 2005). In accordance to our study, excellent results have been reported in 59.1% and good

ones in 27.3% of cases in one previous study (Weigel and Marsh, 2002) In contrast to our study, in their study on 19 patients with condylar tibial fractures, authors reported excellent, good, relative and weak results in 26.6, 31.6, 26.3 and 15.8% of the cases (Zeman and Matejka, 2005). Considering the results of the above-mentioned studies, knee function was very better than other studies. Additionally, using one and half ring instead of one or two hybrid external fixator rings will probably lead to better results due to easiness in joint motions and early starting of the knee joint motions.

CONCLUSION

Application of hybrid external fixator using one and half ring instead of one or two fixator rings in treating bicondylar tibial fractures was associated with desired clinical and radiological results. Although there were high rate of superficial but less problematic infections in our study, further comparative studies are recommended to reach more definite results.

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