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Arthroscopically-Assisted vs. Open Surgery in Repairing Anterior Cruciate Ligament Avulsion

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Abstract: The management of an Anterior Cruciate Ligament (ACL) avulsion is principally by surgery. There are two major techniques in this regard; fixation through open surgery (arthrotomy) or arthroscopically-assisted repair. These are not new in the literature; however, the debate regarding the better approach is still under debate. This study focused on comparing outcome and consequences of arthroscopically-assisted vs. open surgery in repairing ACL avulsion. In a randomized clinical trial, 44 patients with unilateral ACL avulsion were recruited in Tabriz Shohada teaching Centre during a 12 month period of time. These patients were randomized in two equal age and sex-matched groups underwent either arthroscopically-assisted or open ACL repair. The constructive technique was the same in both groups without using any graft. The minimum follow-up period was 6 months including 3 weeks, 3 months and 6 months postoperatively. Range of Motion (ROM), laxity, Anterior Drawer Test (ADT) result, duration of hospital stay, wound status, nonumion and return to previous work were compared between the two groups. Mean time of suture removal ($p = 0.10$), minimum and maximum ROM at months 3 ($p = 0.43$ and 0.22, respectively) and 6 ($p = 0.73$ and 0.77, respectively), ADT at months 3 and 6 ($p = 0.16$ for both), laxity at month 6 ($p = 0.28$) and wound status at week 3 ($p = 0.35$) were not significantly different between the two groups. There was no case of nonumion at month 6 in either group. The mean hospital stay was significantly shorter in the arthroscopy group (3.77±0.92 vs. 2.50±0.51 days; $p<0.001$). The mean laxity score was significantly higher in the open surgery group at month 3 (4.82±0.59 vs. 4.45±0.60; $p = 0.05$). The rate of nonunion was significantly higher in the open surgery group at month 3 (40.9% vs. 9.1%; $p = 0.02$). Patients in the arthroscopically-assisted technique group returned sooner to previous work (17.41±1.53 vs. 14.82±0.96 weeks; $p<0.001$). Based on our results, arthroscopically-assisted reconstruction of ACL avulsion is superior to open surgery.

Key words: Anterior cruciate ligament avulsion, open surgery, arthroscopy, range of motion, laxity, anterior drawer test

INTRODUCTION

Knee is a vulnerable joint to injury, mainly due to its anatomic structure and its pivotal role in daily function of body. The cruciate ligaments, including the anterior and posterior cruciate ligaments (ACL and PCL, respectively) are two of four main stabilizing structures in the knee. The ACL attaches to the knee end of the femur, at the back of the joint and passes down through the knee joint to the front of the flat upper surface of the tibia and its major role is to prevent forward movement of the tibia from underneath the femur. This injury is usually seen as a midsubstance tear in adults but sometimes it tears away from tibial attachment with an accompanying bony fragment (ACL avulsion) (Bucholz *et al*., 2005). ACL injury is one the most common ligamentous injuries in acute trauma, especially during sport. There are estimates that 100,000 new ACL injuries occur annually (Bach, 2003). The management of a torn ACL has not changed significantly for quite a number of years. However, recent findings and advanced clinical and surgical techniques are raising questions about previously accepted approaches in this regard (Fadale and Johnson, 2009). There are two main treatments for ACL avulsion; fixation through open surgery (arthrotomy) or arthroscopically-assisted repair. Although these two techniques are not new to the literature, the available data supporting or opposing each one are numerous (Montgomery *et al*., 2002; Bouattour *et al*., 2002; Song *et al*., 2003; Charrois *et al*.,

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2008). Many of these studies have focused on the grafting material in ACL reconstruction (Lee *et al*., 2010). However, available methodologically appropriate clinical trials concerning the ideal approach- i.e. open or arthroscopically assisted- are scarce. The main benefits of the open technique are proposed to be better exposure and hence, a more anatomical reduction which may lead to lower laxity and its limitations are to be invasive, more damage to soft tissue, more possibility of joint stiffness and higher rate of postoperative infection. The arthroscopically assisted technique is less invasive with lesser soft tissue damage, shorter hospital stay and immobilization time; however, the laxity might be more prevalent (Ahn and Yoo, 2005; Huang *et al*., 2008). Due to indecisiveness in choosing between the two techniques and heterogeneity of repots, this study was aimed to compare the consequences of open and arthroscopically-assisted techniques in repair of ACL avulsion.

MATERIALS AND METHODS

In this randomized clinical trial, 44 patients with unilateral ACL avulsion were recruited in Shohada teaching Centre, Tabriz, Iran, during a 12 month period of time (March 2010 to March 2011). The exclusion criteria were age<18 years, concomitant lesions in other knee ligaments, multitrauma, history of joint disease such as arthritis and diabetes mellitus. These patients were randomized in two equal age and sex-matched groups underwent either arthroscopically-assisted or open ACL repair. All the operations were performed by a single skilled orthopedic surgeon. The constructive technique was the same in both groups without using any graft and only the approaching technique was different (open or arthroscopically-assisted). All the patients were followed up for at least 6 months. The assessor of the patients was blind to the grouping. The Follow-up intervals were 3 weeks (early complications), 3 months (union and complications) and 6 months (union, complications and return to work) postoperation. The Range of Motion (ROM) of knees was measured and reported in degrees. Amount of laxity (score) was measured by arthrometer. Anterior Drawer Test (ADT) was performed on both knees and the difference was reported. Other evaluated variables were patients' demographics (age and sex), smoking history, underlying cause of ACL avulsion, time of suture removal, duration of hospital stay, wound status, nonunion and return to previous work. Rehabilitation was identical for each group. Informed consent was obtained from all the participants. This study approved by the Ethics Committee of Tabriz University of Medical Sciences.

Statistical analysis was performed using SPSS version 19.0 (IBM, USA). The Student's t test, Chi-square test, Fisher's exact test or repeated measures analyses were used where appropriate. A p value of less than 0.05 was considered statistically significant.

RESULTS

The general data of the studied patients in the two groups are summarized and compared in Table 1. Accordingly the patients were matched for age, sex, smoking status and mechanism of injury of ACL. The main outcomes of the study are summarized in Table 2. Accordingly, mean time of suture removal, minimum and maximum ROM at months 3 and 6, ADT at months 3 and 6, laxity at month 6, wound status at week 3 and nonunion rate at month 6 were not significantly different between the two groups. The mean hospital stay was significantly shorter in the arthroscopy group. The mean laxity score was significantly higher in the open surgery group at month 3; indicating a better status in the arthroscopically-operated cases in this regard. The rate of nonunion was significantly higher in the open surgery group at month 3. Patients in the arthroscopically-assisted technique group returned sooner to previous work in a statistically significant manner. The changes of mean minimum and maximum ROM from month 3 to month 6 are depicted in Fig. 1. These changes were not significantly different between the two groups (repeated measures analysis: $p = 0.57$ and 0.41, respectively). The change of mean laxity score from month 3 to month 6 is shown in Fig. 2. This change was not significantly different between the two groups (repeated measures analysis: $p = 0.11$). The change of mean ADT from month 3 to month 6 is shown in Fig. 3. This change was not significantly different between the two groups (repeated measures analysis: $p = 0.16$).

Table 1: Patients' demographics and basic data

Variable	Open surgery (n = 22)	Arthroscopic technique (n = 22)	p-value
Age (year)	30.59±8.18 (18-47)	31.50±11.15 (18-60)	0.76
Sex			
Male	21 (95.5)	21 (95.5)	-
Female	1 (4.5)	1 (4.5)	
Smoking	3 (13.6)	5 (22.7)	0.70
Mechanism of injury			
Sport	9 (40.9)	9 (40.9)	
Accident	8 (36.4)	10 (45.5)	0.70
Fall	5 (22.7)	3 (13.6)	

Data are shown as Mean±Standard deviation (range) or frequency (percentage)

Table 2: Outcomes and complications of arthroscopically-assisted and open reconstruction

Variable	Open surgery (n = 22)	Arthroscopic technique (n = 22)	p-value
Time of suture removal (day)	16.36±1.65 (12-19)	15.64±1.22 (14-18)	0.10
Hospital stay (day)	3.77±0.92 (3-6)	2.50±0.51 (2-3)	<0.001
Minimum range of motion at month 3 (degree)	3.86±2.14 (0-5)	3.27±2.78 (0-10)	0.43
Maximum range of motion at month 3 (degree)	126.82±5.24 (110-135)	128.86±5.55 (120-140)	0.22
Anterior drawer test at month 3 (mm)	1.95±0.21 (1-2)	1.82±0.39 (1-2)	0.16
Laxity at month 3	4.82±0.59 (4-6)	4.45±0.60 (3-5)	0.05
Minimum range of motion at month 6 (degree)	3.73±2.16 (0-5)	3.45±2.96 (0-10)	0.73
Maximum range of motion at month 6 (degree)	128.18±4.24 (115-135)	128.64±6.01 (115-140)	0.77
Anterior drawer test at month 6 (mm)	1.95±0.21 (1-2)	1.82±0.39 (1-2)	0.16
Laxity at month 6	4.64±0.49 (4-5)	4.45±0.60 (3-5)	0.28
Wound (week 3)			
Clean	18 (81.8)	21 (95.5)	0.35
Infected	4 (18.2)	1 (4.5)	
Nonunion			
Month 3	9 (40.9)	2 (9.1)	0.02
Month 6	0 (0)	0 (0)	-
Return to work (week)	17.41±1.53 (15-20)	14.82±0.96 (13-17)	<0.001

Data are shown as Mean±Standard deviation (range) or frequency (percentage)

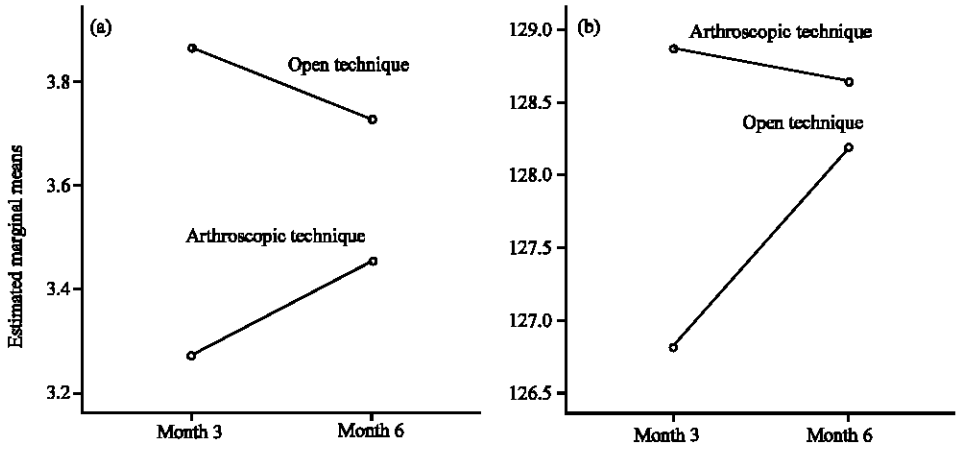

Fig. 1 (a-b): Changes of mean minimum (a) and maximum (b) range of motion of operated knees in two groups from week 3 to week 6

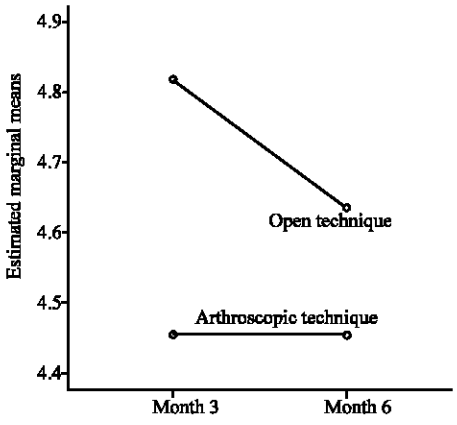

Fig. 2: Change of mean laxity score of operated knees in two groups from week 3 to week 6

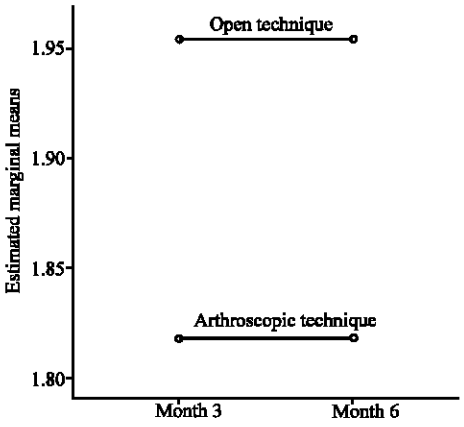

Fig. 3: Change of mean anterior drawer test score of operated knees in two groups from week 3 to week 6

DISCUSSION

In this study, the midterm outcome of ACL avulsion repair was compared between the arthroscopic approach and open arthrotomy. Based on our findings, there was no significant difference between the two groups with regard to time of suture removal, 3- and 6-month ROM, ADT, postoperative infection rate and frequency of nonunion. The mean hospitalization time and return to previous status was significantly shorter in the arthroscopic technique. The laxity score indicated a better condition in the arthroscopic group at month 3 postoperation; however, the two groups were comparable in this regard at month 6. Similar results were documented for union status. Although the arthroscopic technique in treating ACL ruptures is not a new approach in the literature, the available data are not conclusive. In addition, there are very limited data focusing just on the ACL avulsion. Montgomery *et al.* (2002) showed that arthroscopic reduction of avulsion fractures of the ACL was frequently associated with motion complications and often required additional surgical procedures. They concluded that adult patients who undergo this procedure should be counseled regarding the increased risk of motion complications. It has been also previously shown that the arthroscopic repair of the anterior cruciate ligament is a reliable procedure but as failures are observed, indications should take into consideration the type of laxity and the status of the meniscus (Bouattour *et al.*, 2002). On the other hand, Song *et al.* (2003) concluded that the ACL injury can be treated by arthroscopic reconstruction and the clinical result of short-term follow-up is satisfactory. Charrois *et al.* (2008) reported the results obtained with arthroscopic tightening of the ACL in 6 patients. There was no evidence of instability after the arthroscopic tightening procedure. Mean pre- and postoperative differential ADT values were successively 9.2 and 3.9 mm. They concluded that the arthroscopic tightening is an effective and safe technique. In a study by Nikolic *et al.* (2006) arthroscopically assisted ACL reconstruction was typically performed in 139 knees. The feeling of instability prevailed in 94.9% of the knees. Early and late postoperative complications were noticeable in 3.5% each. On the basis of these findings, they concluded that this approach is the method of choice in preventing further "worsening" of the chronically instable knee. As seen, the heterogeneity of data may cause ambiguity in choosing between the best methods available in treating ACL lesions. Our results are in favor of arthroscopic approach comparing with the open technique. To the best of our knowledge, there is very limited number of clinical trials comparing the two methods in a straightforward pattern. Raab *et al.* (1993) performed a pioneer study to determine whether arthroscopically assisted ACL reconstruction offered any significant immediate or short-term advantages over traditional open reconstruction through an arthrotomy. Intraoperative, postoperative and follow-up findings indicated no statistically significant differences or relationships between the two groups in any of the variables measured. The results did not substantiate a clinical advantage for either technique. This is in contrast with our findings which indicate a better outcome for arthroscopically assisted ACL repair over open technique at least in some aspects. Maybe the short-term nature of the above study causes this heterogeneity. Furthermore, this should be emphasized that the mentioned study was one of the first reports in this regard with low-level expertise of the surgeons and the facilities in their era. By the way, they performed the study on ACL reconstruction which is not limited to ACL avulsion. In a prospective, randomized study by Cameron *et al.* (1995), arthroscopic and open ACL reconstructions were compared. There was no significant difference regarding the ADT result. The 1-month postoperative ROM was statistically different favoring the arthroscopic method. Our results are also in conformity with the mentioned study relating to the ROM and anterior drawer test result. Witonski and Kozlowski (1997) reviewed early clinical results in two groups of patients treated by arthroscopy-assisted and arthrotomy ACL reconstruction. Total surgery time, blood loss, pain medication use, length of hospital stay, Lachman test results at 2, 6 and 12 weeks postoperatively and pivot shift test supplemented Lachman test at 6 months follow-up were recorded in both groups. ROM was better in the first group only initially; at three months follow-up no differences were noted. The study results suggest that both open and arthroscopically assisted ACL reconstruction yield similar early clinical results. This study also partly confirms our findings; however, the final conclusion is in contrast with ours. We did not find any significant difference regarding the ROM between the two groups. The reported difference was present in short-term only in the above study. Laffargue *et al.* (1999) compared the results of arthroscopic with open arthrotomy reconstruction of the ACL. Fifty four knees were evaluated, 33 reconstructions were performed with arthrotomy and 21 were arthroscopically-assisted. Follow-up was one year at least. The ROM was better at 3 months postoperative in the arthroscopy group with no significant difference at 6 months. After 3 months, the laxity was significantly higher in the open surgery group with no significant difference at month 6. They concluded that the arthroscopic-assisted procedure apparently

allows a faster rehabilitation. We also found a better status of laxity in the arthroscopy group on the 3rd month with no significant difference for the ROM. In a study by Fremerey *et al*. (2001), 29 patients with ACL rupture were evaluated prospectively. Fifteen patients were operated endoscopically and 14 other patients underwent open surgery. At the final examination after 3.9 years, there were no differences in clinical results and stability between the arthroscopic and the open technique. Although the follow-up time was substantially longer in the mentioned study; we also saw a trend in the outcomes of the two methods with passing time. In other words, two main achievements in the arthroscopically-managed group- the laxity and union status- were comparable at 6-month follow-up. This may indicate a more rapid onset of favorable results in the arthroscopic technique which continually fade by passing time. Further long-term studies might be required for confirming this hypothesis. By the way, satisfactory results of arthroscopic intervention have been reported in long term follow-ups (Fanelli and Edson, 2002). Many factors may influence the outcomes of different studies in this regard. For example, the type of graft is a determinant factor in arthroscopic operation of ACL lesion (Xu *et al*., 2007; Freedman *et al*., 2003; Doral *et al*., 2000; Romanini *et al*., 2010; Lee *et al*., 2010). We completely matched the two groups with regard to the technical factors and patients' specifications. We only recruited the patients with ACL avulsion and no graft was needed. As mentioned earlier, there is limited number of studies comparing the arthroscopic and open repair of ACL. Likewise, the results of these studies are not fully in line with each other. These may be due to different dates of surveys; as the new techniques and equipment may have substantial effect on the outcome of patients. Thus the results of the current study may be helpful in guiding the surgeons in selection of the optimal technique in ACL avulsion.

CONCLUSION

Based on our results, arthroscopically-assisted reconstruction of ACL avulsion is superior to open surgery. This preponderance is at least due to earlier onset of effects which disappear by six months, postoperatively. Further studies comparing different techniques and variety of grafts, as well as cost-effective analysis might be helpful in these patients.

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