Anatomical single bundle anterior cruciate ligament reconstruction by two anteromedial portals

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Abstract

Background
Arthroscopic reconstruction of the anterior cruciate ligament (ACL)tear is a very acceptable method for management of the patients with symptomatic anterolateral knee instability. Anatomical anterior cruciate ligament reconstruction plan for reproduction of the normal anatomy, restores the biomechanics, and preserve the normal function of the knee .

Aim of the work
Evaluation of the results of anatomical single bundle anterior cruciate ligament (ACL) reconstruction by the two anteromedial portals method .

Patients and Methods
Arthroscopic anterior cruciate ligament reconstruction was carried on twenty four patients with ACL tear. The study had been done in Zagazig University hospitals between 2013and 2015. anatomical single bundle anterior cruciate ligament (ACL) reconstruction by the two-anteromedial portals was done for all patients. Evaluation of the functional outcome relied on clinical examination; Lachman test, pivot shift test and KT -1000 arthrometer. The International Knee Documentation Committee (IKDC) score was used for objective assessment while Lysholm score was used for subjective assessment.

Results
The mean follow up period was 20 months (range,15-30 months) At the latest follow up assessment; Lysholm knee score revealed that, 21 patients (87.5%) had excellent or good results, and 3 patients (12.5%) had fair results. The overall IKDC assessment revealed that 22 patients (91.7%) were normal (A) and nearly normal (B), and two patients (8.3%) were abnormal (C). The pivot shift and Lachman tests were 0 in 21 patients (87.5%). Statistically significant improvement was achieved.

Conclusion
Anatomical single bundle anterior cruciate ligament (ACL) reconstruction by two anteromedial portals is a reliable surgical method for reproduction of the anatomy of the ACL that restores anterior and rotational knee stability with good clinical outcome.

Key words
ACL, Two anteromedial portals, Anterolateral knee instability, Rotational stability.

Introduction

The most commonly ligament disrupted in knee injuries is the ACL ligament. Most of these crippling injuries occur in young athletes, disposing them to degenerative arthritis of the tibiofemoral joint. After trauma the primary function of the anterior cruciate ligament is lost, so the tibia can subluxate anterior relative to the femur with repeated episodes of joint instability leading to associated meniscal injury, and more erosion of the cartilage of the joint [1]. So that, reconstruction of the anterior cruciate ligament by arthroscopy is one of the most commonly done orthopedic surgeries. The target of anterior cruciate ligament (ACL) reconstruction is reproduction of the functions of the native anterior cruciate ligament(ACL) [2]. Long term follow up assessment for cases treated by the traditional transtibial two portal technique revealed suboptimum outcome and arthritic changes; and this led to the development of the anatomical single-bundle reconstruction by two anteromedial portals method which more closely restores the native anterior cruciate ligament anatomy[3].

Patients and Methods

Twenty four patients with symptomatic anterior tibial subluxation due to chronic complete tear of the ACL and confirmed by magnetic resonance Imaging; were randomized to undergo anatomical single bundle ante-

rior cruciate ligament (ACL) reconstruction by arthroscopic two anteromedial portals. The study had been done in Zagazig University Hospitals between 2013 and 2015. Quadrupled of semitendinosus and gracilis auto grafts was used in all patients. Endobutton CL (Smith and Nephew) was used for fixation of the femoral side, and bioabsorpable interference screw for fixation of the tibial side . The exclusion criteria included the patients who had multiple ligament injury, chondral injuries; degenerative arthritis and partial ACL tear . The average age of the patients' was 27.5 years (range, 19 to 42).Twenty patients (83.3%) were males and four (16.7%) were females. Fourteen Left knees (58.3%) and ten right knees (41.7%). The patients occupation were 11 students, 7 manual labors, 2 employers, 2 housewives, one butcher, and one driver. The average time from trauma to surgery was 20 months (ranged , 4-48 months). Twelve patients (50%) were injured during sports activity , four patients (16.7%) were injured in road traffic accident, four patients (16.7%) had trauma at labor and four patients (16.7%) had trauma during activities of daily living. All patients had unilateral complete ACL tear. Associated medial meniscus tear was found in 5 knees, and lateral meniscus tear in 3 knees. At the time of ACL reconstruction. Partial menisectomy was performed for these patients.

Preoperative assessment:

Clinical examination of the affected knee by Lachman and pivot shift tests; compared with the normal contra lateral knee was performed few days before operation and under anesthesia just preoperatively. Lachman grading was based on the relative anterior tibial displacement. Grade (0), equal to the normal side, (1+), 3 to 5 mm displacement

difference; (2+), 6 to10 mm and (3+) ,more than 10mm [4]. Pivot shift test result was graded as (0) equal on both knees, (1+) glide, (2+) clunk, and (3+) gross instability [5].

Measurement of the anterior tibial displacement at maximum pressure by the KT -1000 arthrometer and compared to that of the normal side knee.

The function and activity level were assessed by the IKDC scoring system and the Lysholm score. The IKDC scoring system was used for objective assessment [6]. Patients were graded as normal (A), near normal (B), abnormal(C) and severely abnormal (D). The Lysholm score was used for subjective assessment [7]. It had eight items (walking gait, need for external support, knee locking, body instability, frequency of pain, swelling of the joint, stair climbing and squatting ability) questionnaire. The total score is the sum of each response to the eight items, with a total score of 100 points. The Lysholm scale considered the score 95 to100 points to be associated with normal function; 84 to 94 points; with vigorous activity and less than 84 points; with daily living activity.

Operative Technique:

Examination under anesthesia was performed for all patients before anterior cruciate ligament reconstruction to ensure anterior cruciate ligament deficiency by positive Lachman and Pivot shift tests. A standard anterolateral portal was created and diagnostic arthroscopy was done to confirm the diagnosis and evaluation of other pathological conditions. Probing of the ACL ligament to determine laxity while performing lachman's maneuver, and management of any meniscal tears was performed before reconstruction of ACL. Then the stump of the ACL was debrided without removal of the fibers that does not form obstacles for proprioception , vascular and cellular ingrowth. The tendons of gracilis and semitendinosus were obtained as an auto graft. The two anteromedial portals were done. A standard anteromedial portal was established close to the patellar tendon, and the far anteromedial portal was created far away from the former portal (-2 cm from the standard anteromedial portel), Appling a needele at a site which permits for using the reamer without affecting the medial femoral condyle. The standard anteromedial portal permits to visualize the medial wall of the lateral femoral condyle by the arthroscope with the knee in110° of flexion; hence, the femoral insertion site of the anterior cruciate ligament and the posterior cortical bone can be found readily. The far anteromedial portal was used for placement of the guide pin at the center of the insertion site of the anterior cruciate ligament on the femur and establishment of the femoral tunnel using an endoscopic drill bit. Placement of a guide pin at the center of the insertion site of the anterior cruciate ligament on the tibia and a drill bit was used to establish the tibial tunnel, preserving the remaining anterior cruciate ligament tissue. Then, passage of the graft through the femoral tunnel was performed. Endobutton was used for fixation of the femoral side ,and bioabsorbable interference screw for fixation of the tibial after cycling of the graft.

Post-operative rehabilitation:

The accelerated rehabilitation protocol of Shelbourne and Nitz, 1990 [8], was used for postoperative rehabilitation. Full knee extension and full weight bearing were permitted from the first day after the operation. After 2 weeks full weight bearing was permitted with 100° of motion . Light sports was permitted 3 months after reconstruction. Full activities was permitted 6 months after reconstruction.

Post-operative and follow up assessment:

Average follow- up period was 20 months (range; 15 -30 months). The operated knee was evaluated by clinical examination and radiographs after surgery and every 3 months until one year and then every 6 months after that. Clinical examination included Lachman test, pivot shift tests, range of motion and arthrometric measurement of the maximum anterior laxity by the manual KT- 1000 device; compared with the normal contra lateral knee. The function and activity level were evaluated by using the IKDC scoring system and the Lysholm score.

Statistical analysis:

Data including history, basic clinical examination, and coded outcome measures were recorded and analyzed using Microsoft Excel software. Data were then imported into Statistical Package for the Social Sciences (SPSS version 20.0) **(Statistical Package for the Social Sciences)** software for analysis. According to the type of data qualitative data represented as number and percentage , quantitative continues data group represented by mean ± SD or median and range; the following tests were used to test differences for statistical significance;. Paired data were compared by **McNemar's test** and **Wilcoxon signed**-rank tests. The test results were considered statistically significant when p- value **<0.05** and highly significant if p-value <0.001

Results

In all cases, the ACL was reconstructed in the chronic phase (>12 weeks from trauma). At arthroscopy, a mid-substance tear was found in 5 knees (19.8%), and a proximal tear in 19 knees (80.2%). Partial menisectomy was done for 8 patients (33.3%) at the time of ACL reconstruction. At 12 months after operation, the results of the 24 patients were assessed using Lysholm Knee Score and IKDC (International Knee Documentation Committee) assessment.

(1) IKDC Scoring System was used for objective assessment. Preoperatively, IKDC assessment revealed that 16 patients were abnormal (67%), and 8 patients severely abnormal (33.3%). At the last follow up 14 patients (58.3%) were assessed as normal, 8 patients (33.3%) nearly normal, and two patients (8.3%) as abnormal. [Table 1] [Fig. 1]

Table (1): Preoperative and postoperative results of IKDC Score system

Score	Preoperative Patients number (%)	Postoperative Patients number (%)	P-Value	P
Excellent	0(0.0)	16 (66.7)	0.00**	0.00**
Good	2 (8.3)	5 (20.8)	0.02*	
Fair	16 (66.7)	2 (8.3)	0.00**	
Poor	6 (25)	1 (4.2)	0.0001**	

*Sub items compare by **McNemar's test and*** total items by ***Wilcoxon signed**-rank* test. *(*Significant, ** Highly significant*)*

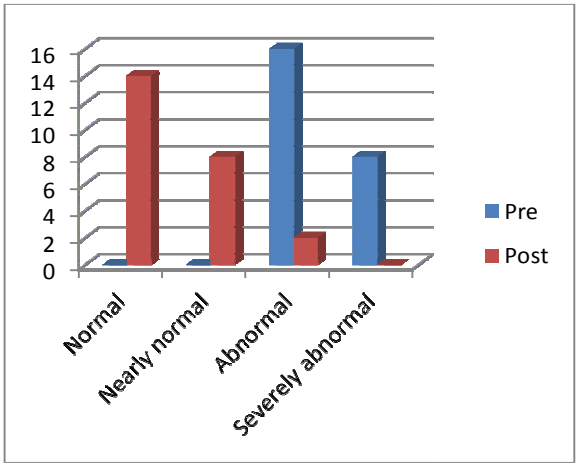

Figure (1): Chart show pre and post operative results of IKDC Score system in the studied group

(2) The Lysholm score:

The Lysholm score is designed for subjective assessment. The mean preoperative Lysholm score was 45, and at the last follow up was 86. There were 2 good cases (8.3%), 16 fair cases (67%) ,and 6 poor cases (25%) preoperatively ,andat the last follow up there were 16 excellent cases (66.7%), cases (20.8%), 2 fair cases (8.3%) 5 good, and there was one case (4.2%) who had a poor result. The patient who had a poor result was 35 years old man who scored 50 and continued to have pain and swelling.[table 2] [fig. 2]

Table (2): Preoperative and postoperative Lysholm score

Score	Preoperative Patients number (%)	Postoperative Patients number (%)	P-Value	P
Excellent	0(0.0)	16 (66.7)	0.00**	0.00**
Good	2 (8.3)	5 (20.8)	0.02*	
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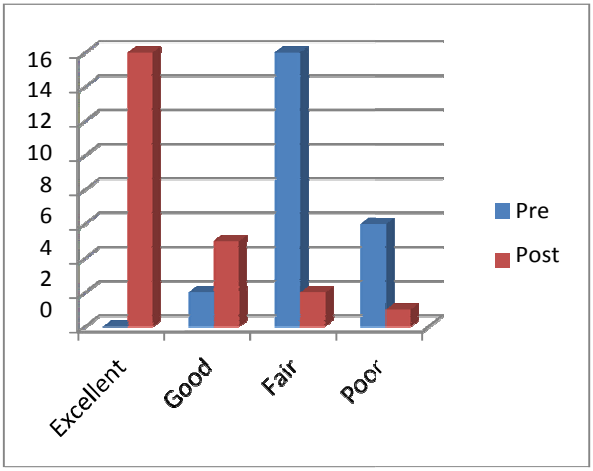

Figure (2): Chart show pre and post operativeLysholm score in the studied group

(3) Assessment of knee joint stability: Lachman test:

The preoperative Lachman test results were, grade 1 in 2 patients (8.3%) grade II in 15 patients (62.5%), and grade III in 7 patients (29.1). At the last follow upassessment, grade 0 Lachman test was demonstrated in 21 patients (87.5%), 2 patients (8.3%) had grade I laxity, and one patient (4.2%) had grade 2 laxity.[table 3, fig.3]

Pivot shift test: The preoperative pivot shift test results were grade I in 6 patients (25%), grade II in 12 patients (50%), and grade III in 6 patients (25%). At the last follow up, the results were grade 0 in 21 patients (87.5%), and grade 1 in the remaining three patients (12.5%).[Table 3, fig. 4]

KT-1000 arthrometer assessment:

In comparison with the normal side. The meanpreoperative anterior tibial displacement value was 9.2±1.9mm (range;6 to14 mm).At the last follow upassessment, the patients had an average anterior displacement 2.4±1.4mm (range;0-7mm). [Table 4 , fig. 5]

Table(3): Preoperative and postoperative results of the Lachman and pivot shift tests

Test	Preoperative Patients number (%)	Postoperative Patients number (%)	P	P-Value
Lachman				
Grade 0	0 (0.0%)	21 (87.5%)	0.00**	0.00**
Grade 1	2 (8.3%)	2 (8.3%)	1.0	
Grade 2	15 (62.5%)	1 (4.2%)	0.00**	
Grade 3	7 (29.1%)	0 (0.0%)	0.00**	
Pivot				
shift				0.00**
Grade 0	6 (25%)	21 (87.5 %)	0.00**	
Grade 1	12 (50%)	3 (12.5 %)	0.00**	
Grade 2	6 (25%)	0 (0.0%)	0.00**	

*Sub items compared by **McNemar's test and*** total items by ***Wilcoxon signed**-rank* test. *(*** Highly significant*).*

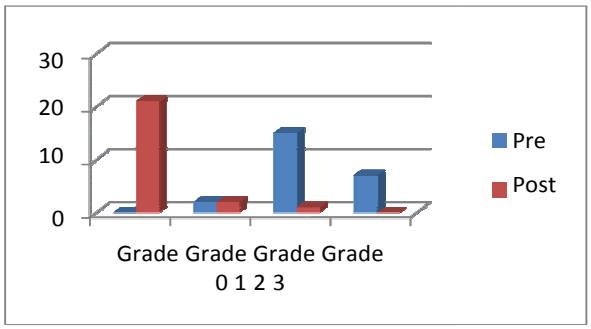

Figure (3): Chart show pre and post operative results of The Lachman test test in the studied group

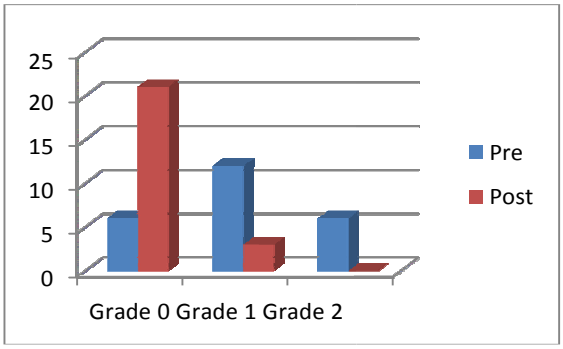

Figure (4): Chart show pre and post operative results of The Pivot shift test in the studied group

Table (4): KT-1000 Arthrometer

KT- 1000 (mm)	Preoperative Patients number (%)	Postoperative Patients number (%)	P-Value	P
<3mm	0(0.0)	16(66.7)	0.00**	0.00**
3-5mm	0(0.0)	7(29.1)	0.00**	
>5mm	24(100)	1(4.2)	0.00**	
Average	9.2±1.9 mm	2.4±1.4 mm	0.00**	

Sub items compared by **McNemar's test and** total items and median by **Wilcoxon signed**- rank test. (** Highly significant)

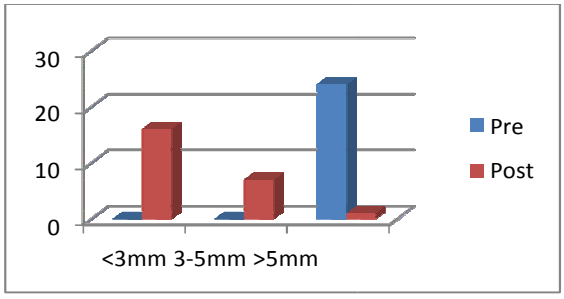

Figure (5): Chart show pre and post operative results of The KT-1000 Arthrometer test in comparison with the normal side in the studied group

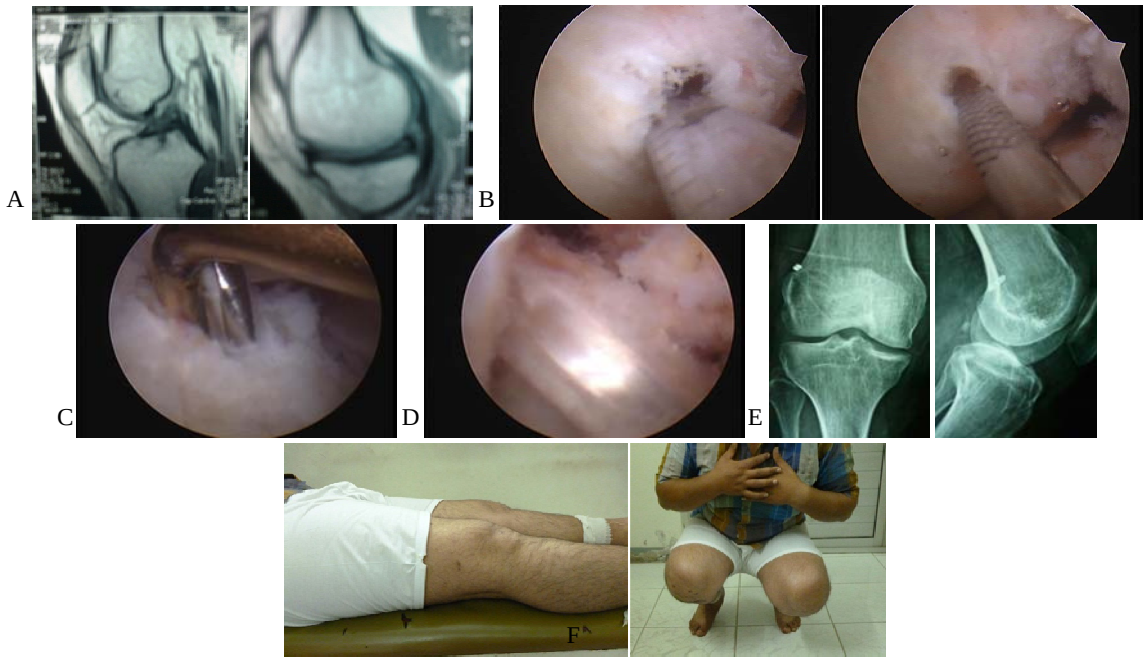

Figure (6): Male patient 21 years old presented with ACL tear. A- M.R.I showing abnormal ACL signal. B- femoral tunnel drilling. C-tibial tunnel drilling D-the final graft position E- postoperative x-ray showing the tunnels position F- Photos show final clinical outcome

Figure (7): Male patient aged 23 years old presented with ACL tear. A- M.R.I revealed abnormal ACL signal. .B-Passage of quadrupled gracilis and semitendinosus auto graft through femoral tunnel. C- postoperative x-ray showing the tunnels position. D- Postoperative MRI showing the graft position. E-Photos show final clinical outcome

Discussion

Restoration of ACL normal anatomy which means functional preservation of its native dimensions and course, collagen orientation and insertion sites will result in a more effective ACL reconstruction and achieves better knee stability [9].

Long term follow up studies revealed that the two portal transtibial femoral tunnel technique failed to place the bone tunnels at the center of the native ACL footprint, especially in the femur. Several disadvantages were identified; the most serious of which is the dependence of the 2 tunnels on each other since the femoral tunnel is drilled through the tibial tunnel and this restricts femoral tunnel location. This often leads to a non-anatomic femoral tunnel position that is too high and deep in the intercondylar notch. This, together with a more posteriorly placed tibial tunnel, will produce a non-anatomic vertical ACL graft course. Although this non-anatomic vertical ACL graft course reduces the anterior-posterior laxity yet it failed to decrease the rotational instability [10].

Recently, with better understanding of the correct bone tunnel positioning and the development of medial portal femoral drilling technique using the accessory far medial portal had allowed for anatomic single or double bundle ACL reconstruction [11-13] Ahn et al [14] compared the anteromedial and transtibial techniques and found a significant vertical course for the graft in the transtibial reconstructions compared with the native ACL. In addition, the more horizontally the graft can be the closer will be the results compared to the native ACL.

Harner and Poehling [15] , utilized the anteromedial portal for placement of the femoral tunnel and reported that it is advantageous as it makes femoral notchplasty unnecessary. For anatomical single- bundle reconstruction, bone tunnels placement are at the center of the insertion sites of the ACL on the femur and tibia. The location of the femoral and tibial tunnels should be matched [16]. This means that the femoral and tibial tunnel locations relative to the ACL footprint should correspond to each other. Many studies have been was done compare postoperative stability and function after anatomical double bundle and single bundle ACL reconstruction. Some studies consider single bundle ACL reconstruction as the option of choice to treat ACL injuries [17-20], whereas others suggested that the anatomical double bundle ACL reconstruction is more efficient in improving pivot shift resistance, increasing rotational knee control, helping in preserving meniscal integrity and limiting progression towards arthritis [10,16, 21-24]. However, final long term follow up assessment of many studies revealed no difference between the two techniques in terms of antero-posterior laxity, rotational stability, and/or any other clinical aspects, but the double bundle technique is technically difficult, ex-

pensive and requires longer operative time.[25-32].

In this series of patients objective assessment was performed by IKDC scale which postoperatively revealed that 14 patients (58.3%) were assessed as normal, 8 patients (33.3%) nearly normal, and two patients (8.3%) as abnormal.

Kim et al. [33] presented a series of 33 patients with anterior cruciate ligament treated by anatomical single bundle ACL reconstruction, the average age of the patients was 29.8. postoperative IKDC assessment revealed that 20 patients (69.7%) were grade A, 9 patients (27.3%) grade B and one patient (3%) grade C. Also; Alentorn-Geli et al. [34] presented a series of 26 patients of anterior cruciate ligament tear treated by anatomical single bundle ACL reconstruction using antero- medial portal method. Postoperative IKDC assessment revealed that all patients having grade (A/B). In another series ; Hussein et al. [35], treated 30 patients by anatomical single bundle ACL reconstruction using the anteromedial portal method. Postoperative IKDC assessment revealed that 26 patients (86.7%) have grade A and 4 patients (13.3%) have grade B. In this series the subjective assessment using the Lysholm score and the postoperative results by this score was 16 excellent cases (66.7%), 5 good cases (20.8%), 2 fair cases (8.3%) , and one case (4.2%) had a poor result, with the postoperative score mean was 86. In the study of Kim et al. [33]; the postoperative Lysholm score revealed excellent results in 19 patients (57.6%) ,good results in12 patients (36.4%) , fair result in one patient (3%) ,and poor result in one patient (3%) with postoperative mean of 88.3. In the study Alentorn-Geli et al. [34]: The mean postoperative Lysholm score was 99.3 ± 2.3. In the study of Hussein et al. [35]: The mean postoperative Lysholm score was 93.5 ±3.

Sohn et al. [36] presented a series of 20 patients with anterior cruciate ligament tear treated by anatomical single bundle reconstruction using anteromedial portals method .Postoperative Lysholm score revealed that all patients had excellent outcome with a mean score of 88.6.

Stability is the keystone for success of the ACL reconstruction. The Lachman test was proved to be the most accurate test for assessment of the ACL laxity [37]. In the current study: A grade 0 Lachman test was demonstrated in 21 of our patients (87.5%), 2 patients (8.2%) had grade I laxity, and one patients (4.2%) had grade 2 laxity, and with KT -1000 arthrometer the patients had an average anterior displacement of 2.4 mm. In the study of Kim et al. [33] the final Lachman test was grade 0 in 28 patients (84.8%) , grade I in 4 patients (12.1%) , and grade II in one patient (3%) . In the study of Alentorn-Geli et al. [34], 21 patients (80.7%) had Lachman test zero grade.

The pivot shift test also was used as a clinical test for the ACL laxity, despite it was inferior in accuracy to Lachman test [38]. In this work: Pivot shift testing showed that 21 (87.5%) of our patients had a grade 0 and 3 patients (12.5%) demonstrated a grade 1 pivot shift. In the study of Kim et al. [33]: The final pivot shift test was grade 0 in 30 patients (90%) , grade I in 2 patients (6%) , and grade II in one patient (3%) .

In the series of Alentorn-Geli et al. [34]: The pivot shift test was 0 in 19 patients (73.1%). In the study of Hussein et al. [35]: The postoperative pivot shift test was grade 0 in 27 patients (90%) , grade I in 2 patients (6.6%) ,and grade II in one patient (3.3%). In the study of Sohn et al. [36]. Postoperative pivot shift test was grade 0 in 18 patients (90%) , and grade I in 2 patients (10%).

Our results are comparable to the results of other studies mentioned above.

Conclusion

Anatomical single bundle anterior cruciate ligament (ACL) reconstruction by two anteromedial portals is a reliable surgical method for reproduction of the anatomy of the ACL that restores anterior and rotational knee stability with good clinical outcome.

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