The Learning Curve in Arthroscopic ACL Reconstruction

The impact on the Surgical Time and Postoperative Clinical Results

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Rupture of the anterior cruciate ligament (ACL) is a common injury. The objective of the current study was to evaluate if the learning curve has an impact on surgical time and postoperative clinical outcomes after anatomic single-bundle anterior cruciate ligament reconstruction (ACLR) using an outside-in tunnel drilling hamstrings technique. The learning curve has a positive impact on surgical time but has no influence on postoperative clinical outcomes at short time follow-up.

Keywords: Anterior cruciate ligament, learning curve, clinical outcomes, surgical time

Rupture of the anterior cruciate ligament (ACL) is a common injury with an incidence of 25-78 per 100,000 [1-3]. Around a third of the patients undergo surgical reconstruction [2] and this, therefore, represents one of the most common orthopaedic procedures in sports medicine [3]. Despite this, considerable controversy still exists regarding nearly all aspects of ACL surgery [3, 4]. The surgical goal is to stabilize the knee joint without restricting the range of motion and prevent secondary damage within an unstable joint like meniscal and cartilage lesions [3-5]. Complex issues have to be addressed in order to achieve the appropriate results [6].

Arthroscopic ACLR is widely accepted as the standard of care for active individuals with functional instability of the knee joint related to ACL injury [7, 8] and surgeons must pass through a learning curve in order to master an ACL reconstruction technique. The achievement of arthroscopic technical proficiency is a complex task. Early arthroscopic learning can be associated with iatrogenic injury, often as damage to articular cartilage [9- 12].

The objective of the current study was to evaluate if the learning curve has an impact on surgical time and postoperative clinical outcomes after anatomic single-bundle anterior cruciate ligament reconstruction (ACLR) using an outside-in tunnel drilling hamstrings technique.

Experimental part

Institutional Review Board approval was obtained. The current study is a retrospective study evaluating patients from a prospectively collected database. A number of 93 patients undergoing anatomic single bundle ACLR between January and December 2016 were evaluated. Surgery was performed by a single surgeon during his first year of independent practice. The patients were divided into 3 equal groups, each of them including 31 cases. The mean age was 33 years (range 21-43 years). There were 29 female and 64 male patients. Mean follow-up was 11.2 months (range 3 months-19 months). The study group included 19 patients without any associated injury and 74 patients with concurrent meniscal surgery (table 1).

Patients with an ACL injury were included in the study. The exclusion criteria were represented by multi-ligament reconstruction, cases using other graft than semitendinosus muscle tendon alone, cartilage surgery and revision cases.

Surgery was performed using a high anterolateral and a standard anteromedial portal. Diagnostic arthroscopy was performed to asses the intra-articular lesions. Femoral and tibial tunnels were drilled using an outside-in technique aiming to position the tunnels within the native ACL footprints. The tripled bundled semitendinosus tendon with a minimum thickness of 7mm was used as autograft. Fixation with biodegradable interference srcews, both, on the femur and the tibia was obtained.

The tourniquet time was noted for all the patients. A similar evaluation protocol was performed for all patients both preoperatively and at 6 weeks, 3, 6 and 12 months postoperatively.

The IKDC Knee Examination Form (IKDC O) was completed by the surgeon. All patients completed the IKDC Subjective Knee Evaluation form (IKDC S), Lysholm Knee Scoring scale and Tegner Activity score. Acomparison regarding tourniquet time and clinical outcomes between cohorts was performed.

Table 1
DEMOGRAPHIC DATA

Mean age	33 years (21 years-43 years)
Gender	
Male	64 (68.80%)
Female	29 (31.20%)
Mean follow-up	11.2 months (range 3 months-19 months)
ACLR alone	19 (20.4%)
Concurent meniscal surgery	74 (79.6%)

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Results and discussions

The mean tourniquet time of the first cohort was measured to be 54±9 min , for cohort 2 43±5 min and 40±3 min for cohort 3. There was an improvement of the tourniquet time for the successive cohorts and this was statistically significant($p<0.05$). There was a better improvement of tourniquet time between cohort 1 and cohort 2 than between cohort 2 and cohort 3, that suggests that the learning curve is ending between cases 31 and 62. Direct comparison between cohort 1 and cohort 3 demonstrated a significant difference($p<0.05$).

There were no statistically significant differences between study cohorts ($p>0.05$) at any of the follow-up points regarding IKDC O, IKDC S, Lysholm and Tegner activity scores (tables 3-6).

From the tourniquet time point of view, the first cohort can be correlated with the improvement of skills then the learning curve is finished between the 31st and 62nd case.Afterwards, the plateau is reached which is correlated to the third cohort.The current study suggests that the learning curve does not influence clinical outcomes.

The current paper describes the impact of the learning curve on the surgical time and clinical outcomes. Many studies have analyzed the learning curves for surgical techniques, especially since the introduction of endoscopic surgery [13-16]. Generally, the acquisition of a new technique progresses at a fast pace in the early stage, but a plateau is reached after a certain period of time [17]. Operative time is the most representative measure used to assess the learning curve because operative time tends to gradually decrease with the surgeon's experience with the technique [17].

Data found in prior studies suggests that it is important for orthopaedic surgeons to understand the nature of any learning curve when implementing new techniques and procedures into practice [7]. The required operative experience and instruction to attain technical competencies remain uncertain and comparison of individual learning curves showed considerable variation among trainees [9].

A-Bing Li et al concluded that with an increased number of surgical cases, the surgical technique is gradually improved and the operation time is shortened [18]. In addition, complications showed no significant differences between the early group and the late group, and the results can be considered acceptable [18]. Jae Chul Lee et al observed a gradual shortening of operative time during the learning curve and there was no significant difference in clinical outcomes between the early and later groups, suggesting that the effect of mastering the technique on

Table 2
TOURNIQUET TIME: COMPARISON BETWEEN COHORTS

	Nr of cases	Mean tourniquet time ± SD (min)	Nr of cases
cohort 1	31	54 ± 9	p<0.05*
cohort 2	31	43 ± 5	p<0.05**
cohort 3	31	40 ± 3	p<0.05***

**as compared to cohort 2, **as compared to cohort 3, ***as compared to cohort 1*

Table 3
THE FREQUENCY OF THE DIFFERENT GRADES OF THE OBJECTIVE IKDC SCORE AMONG THE PATIENTS AT ALL FOLLOW-UP POINTS

Cohort Nr.	IKDC O score	IKDC O 6 weeks	IKDC O 3 months	IKDC O 6 nonths	IKDC O 1 year
	A	7	15	19	26
	B	23	16	12	5
Cohort 1	C	1	0	0	0
	D	0	0	0	0
	A	14	14	23	26
	B	14	17	8	5
Cohort 2	C	3	0	0	0
	D	0	0	0	0
	A	8	18	24	28
	B	17	13	7	3
Cohort 3	C	6	0	0	0
	D	0	0	0	0

IKDC O – IKDC Knee Examination Form, grade A - normal, grade B - nearly normal, grade C - abnormal, grade D – severely abnormal

Table 4
MEAN IKDCS: COMPARISON BETWEEN COHORTS AT ALL FOLLOW-UP POINTS

	Number of cases	Mean IKDS 6 weaks ± SD	Mean IKDS 3 months ± SD	Mean IKDS 6 months ± SD	Mean IKDS 1 year ± SD
cohort 1	31	54.9 ± 11.85	69.58 ± 8.66	81.16 ± 10.04	84.79 ± 9.96
cohort 2	31	58.31 ± 13.20	71 ± 13.59	82.11 ± 8.40	87 ± 10.46
cohort 3	31	63.38 ± 11.05	70.3 ± 9.59	78.86 ± 6.83	88.6 ± 8.54

	Numbers cases	Mean Lysholm 6 weeks ± SD	Mean Lysholm 3 months ± SD	Mean Lysholm 6 months ± SD	Mean Lysholm 1 year ± SD
cohort 1	31	79.87 ± 8.23	85.03 ± 8.02	92.16 ± 6.17	96.41 ±4.08
cohort 2	31	79.68 ± 8.4	83.65 ± 14.10	92 ± 6.54	94.27 ± 4.21
cohort 3	31	77.96 ± 16.53	90.61 ± 6.40	92.30 ± 5.29	95.4 ± 4.33

Table 5
MEAN LYSHOLM SCORE: COMPARISON BETWEEN COHORTS AT ALL FOLLOW-UP POINTS

	Numbers cases	Mean Tegner 6 weeks ± SD	Mean Tegner 3 months ± SD	Mean Tegner 6 months ± SD	Mean Tegner 1 year ± SD
cohort 1	31	3.83 ± 1.21	4.06 ± 0.96	5.19 ± 0.79	5.27 ±1.06
cohort 2	31	3.44 ± 0.68	4.34 ± 1.26	5.11 ±1.05	5.04 ± 1.09
cohort 3	31	3.38 ± 1.54	4.26 ± 1.11	5.26 ± 1.45	5.05 ±1.27

Table 6
MEAN TEGNER SCORE: COMPARISON BETWEEN COHORTS AT ALL FOLLOW-UP POINTS

long-term clinical outcomes is considered to be relatively small during the study follow-up period [19]. This already published data is consistent with the results of the current study.

At early stages of the learning curve the surgeon should be concentrated on performing the surgery while being careful to prevent complications and this can be the reason why the surgical time is longer in early stages of the learning curve but with no significant differences in clinical outcomes between early and later groups [19].

The limitations of the current study are represented by the short follow-up, the small number of patients and the fact that it is a single-surgeon study.

Conclusions

The learning curve has a positive impact on surgical time but has no influence on postoperative clinical outcomes at short time follow-up.

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