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Current trends in reconstruction surgery and rehabilitation of anterior cruciate ligament in Turkey

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Objectives: This study aims to determine the current approaches to surgical techniques and rehabilitation protocols used in anterior cruciate ligament (ACL) reconstruction performed by Turkish orthopedic surgeons and to compare their results with the data of "ACL Study Group".

Methods: A questionnaire consisting of 16 questions on surgical techniques, preoperative prerequisites, routine postoperative applications, rehabilitation approaches, and return to sport following ACL reconstruction was sent via e-mail to the 55 orthopedic surgeons performing annually 25 or more ACL reconstructions.

Results: Response rate to questionnaire was 70.9% (n=39). Nineteen surgeons (48.7%) regularly performed only hamstring tendon (HT) graft, and four surgeons (10.3%) performed only patellar tendon (PT) graft, while 16 surgeons (41%) performed both HT and PT grafts. Three (18.8%) of the 16 surgeons who performed both HT and PT grafts had individual rehabilitation protocols for the two graft types. No statistically significant difference was found between the responses for two graft types in terms of the starting times for specific activities ($p>0.05$). Rehabilitation protocols were similar to the current data of "ACL Study Group". The use of a postoperative brace and continuous passive motion (CPM) was different between Turkish surgeons and "ACL Study Group". The CPM and postoperative brace use was more common in Turkey.

Conclusion: There are only a few differences in the postoperative approach of ACL reconstruction with HT and PT grafts performed by Turkish orthopedic surgeons. The data obtained from the Turkish orthopedic surgeons showed similarities with the "ACL Study Group" current approaches.

Key words: Anterior cruciate ligament; reconstruction/surgery; rehabilitation; Turkey.

Anterior cruciate ligament (ACL) reconstruction is a surgical intervention commonly applied to return patients to their preoperative condition. Rehabilitation of the reconstructed knee is important especially for successfully performing risky and jumping activities.[1] Most commonly used graft types today are quadruple hamstring (semitendinosus/gracilis) tendon (HT) and bone-patellar tendon-bone autografts.[1,2] However, there is still no consensus on which graft type is the best option.[2,3] Patellar tendon (PT) autograft, which had been considered as the "gold standard" in ACL reconstruction for a long time, was criticized due to donor site morbidity despite its high success rates.[3] Complications may be seen, such as

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quadriceps weakness,[3] extension loss,[2] anterior knee pain,[2-5] patella fracture,[3-5] patellar tendinitis,[3] ligament rupture and infrapatellar contracture formation.[4,5] Today, the use of combined semitendinosus and gracilis tendons is gradually increasing due to low donor site morbidity rates.[4,5] Yet, HT procedure is not free from complication. It has been shown that tunnel expansion following autograft HT application is more common in comparison with PT application.[6,7] Other disadvantages reported are longer tendon-tunnel recovery period and hamstring weakness.[3]

Attributes of graft material, graft recovery, graft fixation, specific morbidities are important factors in determining the rehabilitation program.[8,9] Nevertheless, there is still no definite answer to the question "Is it necessary to differentiate rehabilitation programs in accordance with different graft types?".[10]

Accelerated rehabilitation programs that suggest restoring the range of motion in an early period, early loading and returning to contact sports in 6 months are widely accepted today.[11] But these protocols were designed according to PT use.[12] Soft tissue recovery of HT grafts requires at least 8-12 weeks, and accelerated rehabilitation protocols may improve graft-tunnel movement during this period.[13] Yet, it is not clear what kinds of changes are required to be made in rehabilitation protocols. Some researchers think that the early rehabilitation phase following ACL reconstruction with HT graft should be more conservative,[7,14] while some hold the opinion that HT and PT groups do not show any difference in the short term as a result of the accelerated rehabilitation protocol.[15] In two sources published in our country where authors transfer their own clinical experiences, the authors preferred more conservative rehabilitation after using HT graft.[8,16]

In our country, there is no available study on the graft type, surgical method, preoperative prerequisites, postoperative applications required, and rehabilitation approach preferred by orthopedic surgeons in ACL reconstruction. There are similar studies available made in Avustralia[17] and United Kingdom[18] in literature. This study was designed to provide data on the surgical applications and rehabilitation approaches adopted by knee surgeons who perform 25 or more ACL reconstructions in a year and to determine whether they follow different rehabilitation approaches depending on different graft types. In the study, surgical applications and rehabilitation approaches of surgeons were compared to the current approaches of "ACL Study Group".[19] "ACL Study Group", which was founded 25 years ago, has more than 120 members from various countries. It comes together biennially and updates information; its last meeting was held in February 2010 (www.aclstudygroup.com).

Materials and methods

A questionnaire of 16 questions was prepared on parameters of rehabilitation and surgical applications of surgeons in Turkey who perform 25 and more ACL reconstructions annually (Fig. 1). The questionnaire included questions about causes of injury, graft type used, type of surgery applied, preoperative prerequisites, postoperative applications required, full loading duration, total period recommended for rehabilitation, starting time for specific exercises and activities, and applications required before returning to sports. The questionnaire was designed to be self-filled in by the surgeons and consisted of only closed-end questions that require categorical answers. In questions on the starting time of specific activities and exercises, choices were categorized so as to provide a standard and to facilitate the completion of questionnaire forms. In the 12th question that asks only the starting time of specific activities and exercises, the surgeons who follow different protocols for PT and HT were asked to answer this question separately for each protocol.

The questionnaire was sent via e-mail to 55 knee surgeons who perform 25 and more ACL reconstructions annually.

Descriptive statistics (mean, standard deviation, minimum-maximum values, frequency values, percentages) were used in the evaluation of data. Different applications about HT and PT graft use were compared by chi-square and Fisher exact probability test. The p values below 0.05 were considered statistically significant.

Results

Of 55 surgeons, 39 responded to our questionnaire. Response rate was 70.90%. The mean number of annually performed ACL reconstructions was 74.95±68.253 (range 25-300). Of the surgeons, 48.7% (n=19) applied only HT graft, while 10.3% (n=4)

Fig. 1

Study questionnaire

Mark "☐" symbol with "X"; and complete the empty space for open questions.

1. **How many ACL reconstructions are you performing per year? .....**
2. **Please mark the graft type you use.**
   HT ☐ PT ☐ Both ☐ Other: Please explain……..
3. **Please mark the surgery type you use.**
   Double band ☐ Single band ☐ Both ☐
4. **Do you have any below prerequisites for the preoperative condition of the knee?**
   To provide full range of motion: Yes ☐ No ☐
   Good quadriceps function: Yes ☐ No ☐
   No or limited effusion: Yes ☐ No ☐
5. **Do you have particular routine applications postoperatively?**
   Cryocuff/ice: Yes ☐ No ☐
   CPM: Yes ☐ No ☐
   Breys/splint: Yes ☐ No ☐
6. **What is the duration of loading postoperatively?**
   As much as it is tolerated ☐
   I do no allow loading for …... weeks.
   I allow limited loading at …... weeks, allow full loading at ……. weeks.
7. **Do you limit full flexion at the knee?**
   Yes ☐ No ☐
   If yes; what is the duration and degree: …… days/weeks; …….. degree
8. **Which of the below do you prefer following ACL reconstruction?**
   Home exercise programs ☐
   Professional rehabilitation programs ☐
9. **If you prefer professional rehabilitation programs, when do you start the program and how long you suggest patient to continue the program?**
   I start the patient to rehabilitation program at ..... d/months postoperatively in hospital, I suggest him/her to continue the program for ..... weeks/months after discharge from hospital.
   I discharge my patient from hospital by giving home execise programs, start rehabilitation program at ..... d/months postoperatively and suggest him/her to continue the program for ..... weeks/months.
10. **Do you have standard rehabilitation program?**
    Yes ☐ No ☐
    If yes; Is your protocol different for HT and PT?: Yes ☐ No ☐
11. **Do you use proprioceptive exercise in rehabilitation program?**
    Yes ☐ No ☐
12. **When do you start below specific activities/exercises? (If you use different protocols for, please mark starting time by writing HT or BT next to the boxes)**

Proprioceptive exercise (rocker board, simple balance boards)	≤2 weeks ☐	2-4 weeks ☐	4-6 weeks ☐	≥6 weeks ☐
Exercise bicycle	≤2 weeks ☐	2-4 weeks ☐	4-6 weeks ☐	≥6 weeks ☐
Jumping in trampoline	≤4 weeks ☐	4-6 weeks ☐	6-8 weeks ☐	≥8 weeks ☐
Running in treadmill	≤4 weeks ☐	4-6 weeks ☐	6-8 weeks ☐	≥8 weeks ☐
Running in outside	≤4 weeks ☐	4-6 weeks ☐	6-8 weeks ☐	≥8 weeks ☐
Strengthening open kinetic chain quadriceps:				
Between 90-40°	≤6 weeks ☐	6-12 weeks ☐	3-6 months ☐	≥6 months ☐
Skills on sports not requiring contact	≤2 months ☐	2-4 months ☐	4-6 months ☐	≥6 months ☐
Return to sports not requiring contact	≤3 months ☐	3-4 months ☐	4-5 months ☐	≥6 months ☐
Return to sports requiring contact	≤3 months ☐	3-4 months ☐	4-5 months ☐	≥6 months ☐

13. **Do you use isokinetic exercises for strengthening?**
    Yes ☐, I start at ……. weeks/months No ☐
14. **Do you apply routine strength test before returning to sports? (e.g. isokinetic system)**
    Yes ☐, I start at ……. weeks/months No ☐
15. **Do you use KT 1000/2000 (or equivalent) arthrometer device?**
    Yes ☐, I start at ……. weeks/months No ☐
16. **Do you use breys and/or similar support use after returning to sports?**
    Yes ☐ No ☐

applied only PT graft, and 41% (n=16) applied both PT and HT grafts. Of 16 surgeons, who applied both grafts, 18.8% (n=3) followed separate rehabilitation programs for HT and PT. Since some surgeons used both grafts, 35 surgeons in total completed the questionnaire according to HT graft and 20 surgeons completed the questionnaire according to PT graft. There was no statistically significant difference in any of the answers between the starting times of specific activities determined for two graft types ($p<0.05$).

Regarding the surgical technique used, 51.3% (n=20) of the surgeons used only single band technique, while 5.1% (n=2) used only double band technique and 43.6% (n=17) used both single and double band techniques.

When preoperative requirements are considered, prerequisite of achieving full range of joint motion was 94.3% for HT (n=33) and 100% for PT (n=20). Prerequisite of having good quadriceps function was 85.7% for HT (n=30) and 78.9% for PT (n=15). Prerequisite of having no or little effusion was 71.4% for HT (n=25) and 65% for PT (n=13).

Considering postoperative routine applications, the rate of cryocuff/ice use was 94.3% for HT (n=33) and 84.2% for PT (n=16). Continuous passive motion (CPM) use was 68.6% for HT (n=24) and 65% for PT (n=13); brace use was 54.3% for HT (n=19) and 60% for PT (n=12).

While 84.4% of surgeons (n=27) using HT and 76.5% of surgeons (n=13) using PT allowed patients to load the operated knee as much as it is tolerated, other surgeons limited the loading at different durations. While 57.1% (n=20) and 60% (n=12) of surgeons did not limit full flexion for HT and PT, respectively, others limited the flexion at different durations and degrees.

Preference rate of professional rehabilitation was found to be 63.6% for HT (n=21) and 60% for PT (n=12). While 24.2% of the surgeons (n=8) preferred home program for HT, 35% (n=7) preferred home program for PT. The rate of surgeons who used both home and professional rehabilitation programs depending on the patient was found to be 12.1% (n=4) for HT and 5% (n=1) for PT. The rate of proprioceptive exercise use in rehabilitation program was 100% (n=39). Starting times for specific activities/exercises are given in Table 1.

The rate of routine strength test application before returning to sports was 45.7% (n=16) for HT and 40% (n=8) for PT. The rate of KT 1000/2000 (or equivalent) arthrometer device use was 25.7% (n=9) for HT and 35% (n=7) for PT. The rate of orthesis

Table 1

Starting times for specific activities/exercises [n (%)]

	≤2 weeks	2-4 weeks	≤3 weeks	4-6 weeks	≥6 weeks	6-8 weeks	≥8 weeks	p value
Proprioceptive exercise	4 (7.3)	22 (40)		19 (34.5)	10 (18.2)			0.607
Exercise bicycle	3 (5.7)	27 (50.9)		16 (30.2)	7 (13.2)			0.757
Jumping in trampoline				2 (3.8)		16 (30.8)	34 (65.4)	1.000
Running in treadmill				4 (7.7)		9 (17.3)	39 (75)	0.881
Running in outside				1 (1.8)		8 (14.5)	46 (83.6)	1.000
90-40° quadriceps strength			18 (32.7)	7 (12.7)		19 (34.5)	11 (20)	0.957
	≤6 weeks	6-12 weeks	≤3 months	3-4 months	4-5 months	3-6 months	≥6 months	p value
Full archus quadriceps strength	4 (20)	9 (45)				5 (25)	1 (5)	0.745
Return to sports not requiring contact				2 (3.6)	28 (50.9)		25 (45.5)	0.541
Return to sports requiring contact					9 (16.4)		46 (83.6)	0.133

and similar support use after returning to sports was 8.6% (n=3) for HT and 15% (n=3) for PT.

When starting times for specific activities and exercises were compared, surgical approaches were very close to those introduced by "ACL Study Group" data.[19] While bicycle use until the 3rd week in ACL study group was permitted by 67%,[19] this rate was observed to be 62.5% in PT users and 52.9% in HT users between weeks 2 and 4 according to the results of our questionnaire. While 83.6% of surgeons (n=46) allowed patients to return to risky sports in 6 or more months, this rate was 75% for 6th month in ACL study group. However, it was determined that surgeons in our country are more conservative in terms of postoperative brace use [23% in "ACL Study Group", and 54.3% (n=19) for HT and 60% (n=12) for PT according to the results of our questionnaire, (p=0.68); and CPM use was preferred at the rate of 39% in "ACL Study Group" while this rate was 68.6% (n=24) for HT and 65% (n=13) for PT according to our questionnaire results (p=0.79)].

Discussion

According to the results obtained from our questionnaire, the use of HT graft was preferred more compared to PT graft [HT 89.7% (n=35), PT 51.3% (n=20)]. In ACL study group, preference rate for HT and PT grafts was 50% and 39%, respectively.

In terms of the surgical technique used, preference rate for double band technique was observed to be very high. Of surgeons, 43.6% used both single and double band techniques and 5.1% of surgeons used only double band technique (48.7% in total). The rate of double band technique use in "ACL Study Group" was 19%.

At the end of our study, no statistically significant difference was found between the surgeons' rehabilitation approaches after HT and PT use. The comparison with "ACL Study Group" revealed no differences in terms of starting times for specific activities. When postoperative routine applications were considered, CPM and postoperative brace use of surgeons was more common in comparison with "ACL Study Group". CPM use was preferred at a rate of 47% in "ACL Study Group", while this rate was 68.6% (n=24) for HT and 65% (n=13) for PT in our country (p=0.79).

Smith and Davies,[20] reviewed eight studies (seven randomized controlled studies, one clinical study) on 505 ACL reconstructions in order to investigate the efficiency of CPM use after ACL reconstruction, and reported that there was no difference between the use and non-use of CPM in terms of joint laxity, functional skills, postoperative complications, radiological changes, ecchymosis and muscle atrophy, and that the effect of CPM on range of motion, pain, swelling, blood loss, patient satisfaction and duration of hospital stay was uncertain.[20]

Postoperative brace use was preferred at a rate of 23% in "ACL Study Group", while this rate was 54.3% (n=19) for HT and 60% (n=12) for PT in our country (p=0.68). In several studies conducted in late 1990's to investigate the efficiency of brace use, it was concluded that brace use had no significant effect.[21-24] This result is also supported by the current reviews.[25-26]

Smith and Davies[25] evaluated 7 controlled clinical studies in a systematic compilation where they investigated the efficiency of brace use in the early period following ACL reconstruction. At the end of their study, they reported that there was no difference between the long-term results of patients who received treatment with and without brace. Wright and Fetzer[26] could not find any proof supporting the positive effect of postoperative brace use on pain, range of motion, graft stability and prevention of injuries in their compilation that they reviewed 12 randomized and controlled studies. However, all studies included in both of these compilations aimed to evaluate the efficiency of brace use after PT graft application.

There is still no sufficient literature information on brace use after HT graft application. The only study on this subject was conducted by Vadala et al.[14] who assigned full extension brace and only isometric exercise for 2 weeks to a group of patients receiving ACL reconstruction using HT graft and started range of motion (ROM) exercises after removing the brace at the end of 2 weeks; and in the other group they started ROM exercises immediately after the surgery and did not recommend brace use. Consequently, they reported that accelerated rehabilitation and non-use of brace in ACL reconstruction performed by using HT graft may increase bone tunnel expansion.[14]

The present study is of vital importance as it is the first study conducted in our country to introduce the surgical and rehabilitation approaches of knee surgeons who intensively perform ACL reconstruc-

tion. The results obtained from the study were similar to those of the current approaches used in "ACL Study Group".

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