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Original Research Article

EFFECT OF MENISECTOMY ON RECOVERY OF PROPRIOCEPTIVE DEFICITS FOLLOWING ARTHROSCOPIC ACL RECONSTRUCTION

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ABSTRACT

Introduction: Decrease in proprioception and kinesthesia occurs after ACL injury. Changes occurring within the joint following injury affect normal recruitment and firing patterns of the surrounding musculature. There are little data in the literature with reference to effect of concomitant menisectomy on recovery of proprioceptive deficits after arthroscopic ACL reconstruction.

Objective: To determine the effect of concomitant menisectomy on proprioception recovery after arthroscopically assisted anterior cruciate ligament (ACL) reconstruction with quadrupled hamstring graft.

Materials and Methods: In this study, 42 arthroscopic ACL reconstruction patients were randomized into Group ACL+MM which underwent ACL reconstruction and menisectomy for concomitant meniscal tears and Group ACL who underwent ACL reconstruction alone. Outcome Assessment was done at 1 month, 3, 6 and 12 months after the surgery in which patients were assessed using Star excursion balance test by measuring excursion distances in each of the 8 directions.

Results: Excursion distances in eight directions showed less increment inACL+MM group with compared to ACL group. However it was found to be statistically significant only for posteromedial, lateral and medial directions.

Conclusion: Concomitant menisectomy does affect the recovery of dynamic proprioceptive deficits and the recovery phase is longer after arthroscopically assisted anterior cruciate ligament (ACL) reconstruction compared to ACL reconstruction alone.

KEY WORDS: Star excursion balance test, Anterior cruciate ligament, Dynamic proprioception, Postural Stability.

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INTRODUCTION

The Anterior cruciate ligament plays an important role in the stability of the knee primarily through its passive constraint to anterior tibial translation and tibial rotation. Also it influences the dynamic function of the knee [1]. Knee injuries and knee surgery cause damage to part of the mechanoreceptors needed to collect proprioceptive information. Studies suggest that impaired knee proprioception may increase the risk of micro-trauma, thereby leading to early degenerative knee lesions [2,3].

Decrease in proprioception and kinesthesia occurs after ACL injury. Changes that occur within the joint affect normal recruitment and timing patterns of the surrounding musculature. In the ACL deficient (ACLD) knee, movement occurs in a non-physiological axis, creating alterations in

gait and movement [4]. The sensation of instability and giving way that the ACLD patient describes has been attributed to poor proprioception [5] in addition to the actual functional instability. ACL injury has been associated with a resultant decrease in proprioceptive performance, with this relationship between ACL rupture and decreased proprioception being reported to be due to damage to the mechanoreceptors in the articular structures and ACL [6].

Studies have also indicated [7,8] that knee proprioception is decreased in both partially and totally meniscectomized knees due to the loss of mechanoreceptors present in the resected meniscus.

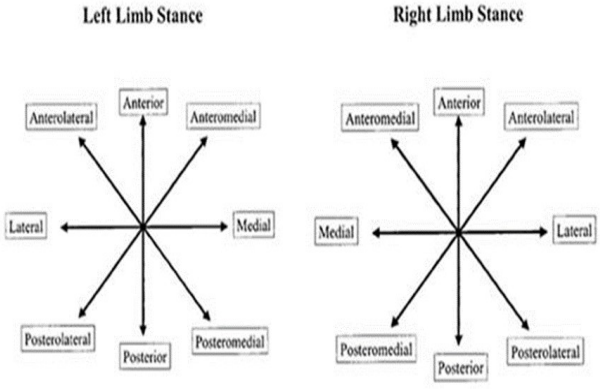
However, it is unclear whether postural stability would be further reduced in patients who also have meniscal tears combined with ACL tears compared to ACL tears alone and extent of recovery and progression following surgical intervention. So, we conducted this study to determine the effect of concomitant menisectomy on proprioception recovery after arthroscopically assisted anterior cruciate ligament (ACL) reconstruction with quadrupled hamstring graft.

MATERIALS AND METHODS

This prospective longitudinal trial enrolled patients who were candidates for ACL reconstruction between 2015 and 2016 were included in the study. Patients were included only if they had ACL ruptures associated with medial meniscus tears (ACL+MM group) or unilateral isolated ACL ruptures (ACL group) based on the MRI and arthroscopic findings. They were then followed up for the duration of one year post operatively. Patients with ACL tear presenting after six weeks but before six months from the date of injury, patients with ACL tear who had minimum of 120 degrees of flexion possible at the knee before surgery and had no pain in the affected knee were included in the study. Patients with multi ligament injuries, Presence of fractures or deformities in the lower limb, revision anterior cruciate ligament reconstruction were excluded. Patients associated with lateral meniscus tears were excluded to eliminate bias resulting from meniscus location. Individuals with prior experience of dynamic balance testing were excluded to eliminate a learning curve effect.

Proprioception analysis was assessed using star excursion balance test (SEBT).Patients who were to take the test were selected based if they had no history of ankle injury, no history of cerebral concussions, no ear infection or upper respiratory infection at the time of test, no prior balance training. To perform the SEBT, subjects were asked to stand on one foot and reach as far as they could in each of 8 different directions with the other foot, touching down lightly on the line, then return to the starting position as shown in (Figure 1). Subjects maintained a single-limb stance until they returned to the starting position. The 8 directions extend out in a circle and each target line is 45° from the adjacent lines. Each direction is completed as a separate trial and reach distance is recorded in centimeters. Three practice trials were permitted for each lower extremity to minimize learning effect. Subjects were then allowed to rest and completed 3 measured trials on each lower extremity. The mean reach distance for each lower extremity was recorded. Trials were discarded and repeated if the hands were removed from the hips, the reaching limb was used for weight bearing, the stance limb was displaced or there was a loss of balance.

Fig. 1: The 8 positions of the SEBT are based on the stance of the affected limb.



The type of anesthetic (regional or general) was not controlled and was selected at the discretion of the anesthesiologist. All patients received prophylactic intravenous antibiotics preoperatively. A pneumatic tourniquet was used following exsanguination to produce a relatively bloodless operative field. Same team of surgeons performed all of the ligament reconstructions

in the patients in this study. The anterior cruciate ligament was reconstructed with quadrupled hamstring graft, harvested from the ipsilateral knee under tourniquet. Trans-tibial technique was used in graft placement. Anchorage of the graft was done using bio-absorbable interference screws at tibial side and either cross pins or endobutton for femoral side. The knee was closed primarily and 3 layered compressive dressing was placed on the knee of all patients. A knee immobilizer was applied for all the patients for first 2 weeks at rest. Patients were allowed partial weight bearing from the next day after gait training with bilateral axillary crutches. All patients were encouraged to elevate the extremity when not performing therapy. Postoperative rehabilitation was performed in accordance with the accelerated ACL protocol and was identical in both the groups. Similar postoperative analgesia regimen was followed. Assessment was done on postoperative 1, 3, 6 and 12 months after the surgery based on the same criteria considered preoperatively. Results were expressed as mean± SD. Statistical analysis was performed by using repeated-measures analysis of variance (ANOVA). Independent sample t-test was used to compare the treatment group and control group over a period of time. The difference between the two groups was considered significant if the p value was < 0.05.

RESULTS

There were 46 patients who met the inclusion criteria for the study. Four were lost to follow-up after surgery. Therefore, 42 patients were alternatively allocated either the ACL+ MM group (21) or the ACL group (21).

The final population (Table 1) comprised 36 men (ACL+MM group=19; ACL group=17) and 6 women (ACL+MM group=2; ACL group=4) with a mean age of 32.85+/-5.68 years (ACL+MM group= 32.65 ± 5.43; ACL group=33.05 ± 5.93). Those less than 28 years of age were comprised mainly of students. The gender distribution of cases was eccentric with more males than females in the study. This can be explained on the basis of lower rates of road traffic accidents among females and lesser participation in sports activities. The mean body mass index was 25.71+/-3.26 kg/m2 (ACL+MM group =26.19 ± 3.75; ACL group=25.24 ± 2.77). The mean duration of symptoms was 9 months (ACL+MM = 8.65 ± 2.44; ACL= 9.7 ± 1.47).

Table1: Demographic characters of the study group.

Variables	ACL+MM	ACL
No. of patients	21	21
Female: male	2:19	4:17
Age	32.65 ± 5.43	33.05 ± 5.93
BMI	26.19 ± 3.75	25.24 ± 2.77
Right: Left	8:13	11:10
Duration months	8.65 ± 2.44	9.7 ± 1.47

8 operations in the right and 13 in the left knee were performed in the ACL+MM group and 11 in the right and 10 in the left knee in the ACL group. No infection was observed after surgery in both groups. The study group had 71% (n=30) patients who were involved in sports and outdoor activities before injury compared to 20% (n=12) patients who were involved in sedentary occupation.

Pre-operative mean excursion distances (Table 2) showed decline in ACL+MM group when compared to the opposite limb and these differences were statistically significant in all the directions. ($p<0.05$) In ACL group also, mean excursion distances were less compared to normal opposite limb taken as control and differences were statistically significant($p<0.05$) except for anterior and lateral directions. (ANT:0.26; L: 0.08)

Table 2: Mean excursion distance comparison between affected limb and normal unaffected contralateral limb in ACL+MM and ACL groups in 8 different directions.

ACL+MM		AFFECTED	UNAFFECTED	P VALUE
	ANT	78.82	82.5	0.007
	AM	74.14	79.18	0.001
	AL	79.5	83	<0.001
	L	74.91	81.73	0.001
	POST	74.18	83.59	<0.001
	PM	72.86	78.95	0.005
	PL	77.18	81.95	<0.001
	M	63	65.95	<0.001
ACL				
	ANT	84.95	86.73	0.26
	AM	76.77	74.14	0.126
	AL	84.14	89.36	0.004
	L	82.27	86.67	0.085
	POST	71.64	77.77	<0.001
	PM	67.23	73.64	0.011
	PL	78.95	83.45	0.002
	M	52.45	64.23	<0.001

(ANT=Anterior; AM=Anteromedial; AL=Anterolateral; L= Lateral; POST= Posterior; PM= Posteromedial; . PL= Posterolateral; M= Medial)

When followed up the patients (Table 3) over a period of 12 months, ACL+MM group showed improvement in excursion distances in all the directions compared to pre- operative values. These difference was clinically significant in all directions and statistically significant in Medial, Lateral, Posterior, Posteromedial and posterolateral directions. (p<0.05)

Table 3: Mean excursion distance improvement over a period of follow-up of 12 months in ACL+MM and ACL groups in 8 different directions.

ACL+MM	PRE OP	1 MONTH	3 MONTHS	6 MONTHS	12 MONTHS	P VALUE
ANT	78.82	78.77	79.45	76.05	79.82	0.435
AM	74.14	74.82	75.82	75.27	75.18	0.711
AL	79.5	78.86	78.86	79.36	79.27	0.933
L	74.91	74.14	76.14	78.68	77.59	0.004
POST	74.18	71.27	72.18	73.95	75.82	0.043
PM	72.86	67.41	70.32	74.86	74.9	<0.001
PL	77.18	77.27	78.27	79.86	79.45	0.04
M	63	54.09	57.23	61.68	62.64	<0.01
ACL						
ANT	84.95	81	81.86	84.32	84.77	0.002
AM	76.77	75.68	76.32	77.45	79.36	0.002
AL	84.14	81.27	82.27	83.05	86.18	0.001
L	82.27	78.23	79.41	82	81.82	0.047
POST	71.64	69.5	70.41	72.36	75.05	<0.001
PM	67.23	63.86	64.86	68.68	72.41	<0.001
PL	78.95	77.14	77.77	79.64	80.36	0.06
M	52.45	49.41	53.68	57.18	63.41	<0.01

ACL group also showed improvement in excursion distances in all the directions which was clinically significant in all directions and statistically significant (p<0.05) in all except posterolateral directions. (p=0.06)

On comparing final mean excursion distances (Table 4) of ACL+MM group with ACL group, all the directions in ACL group showed more clinical increment compared to ACL+MM group. However, this clinical improvement was statistically significant in three of the eight directions: posteromedial; medial and lateral direction. (p for PM=0.018; M<0.01; L=0.034)

Table 4: Comparison between ACL+MM group and ACL group after 12 months.

Direction	p-value
AM	0.159
ANT	0.52
AL	0.102
L	0.034
PL	0.508
POST	0.22
PM	0.018
M	<0.001

DISCUSSION

One of the most frequently damaged structures in the knee is the anterior cruciate ligament (ACL), particularly in young people who are physically active. Ligament injuries are usually accompanied with damage to one or both menisci and/or to the articular cartilage. Injuries are 5 times more common in the medial meniscus (MM) than in the lateral meniscus. In most cases, injuries of the ACL and MM result in impaired knee proprioception [9].

The concentration of the mechanoreceptors involved in proprioception is highest in the posterior corner of the MM and at the proximal and distal attachments of the cruciate ligaments to the bones [10,11].

Injuries to ligaments, one or both menisci, and/or the articular cartilage in the knee cause partial damage to the mechanoreceptors contained in these structures, thereby inducing disorders in both static proprioception and kinaesthesia [12,13]. Another consequence is mechanical instability, which can further impair body balance [2]. Therefore, ACL and MM injuries usually require both surgical treatment and specialised rehabilitation emphasising proprioception training [14].

Neuromuscular training is typically used to enhance athlete's preparation, performance and recovery by improving dynamic postural stability which is an integral component of lower limb neuromuscular control. Whereas static measures of postural-control provide useful clinical information, the underlying task of standing as still as possible might not translate necessarily to movement tasks during physical activity. Conversely, dynamic postural-control involves some level of expected movement around a base of support.

Most studies of the impact of meniscus tears on knee joint proprioception have used joint position sense tests, with joint position measured after partial or total meniscectomy. A case– control study comparing 19 patients with medial meniscus posterior horn tears at a mean 2 years after partial meniscectomy with 20 healthy individuals on knee angle reproduction tests found that the former group showed more deviation than did the control group, indicating

poorer proprioception in the meniscectomized than in the control group [15].

Evaluation of the change in joint position sense in patients who underwent meniscus allograft transplantation (MAT) for totally meniscectomized knees showed that, compared with preoperative measurements, proprioception significantly improved 6 months after MAT [16]. Taken together, these studies indicate that knee proprioception is decreased in both partially and totally meniscectomized knees due to the loss of mechanoreceptors present in the resected meniscus.

Few studies have evaluated the effect of meniscus tears on postural stability. A comparison of postural stability using the balance index in subjects with and without meniscus tears found that overall balance performance was significantly better in participants without meniscus tears [17]. In contrast, a prospective posturographic evaluation of postural stability in 27 patients with unilateral meniscal lesions showed no differences in stability indexes on the injured and uninjured sides [18].

These discrepancies in different studies may be due to differences in the location and extent of meniscus tears, differences in subject age or sports activities, and to the lack of a standardized measurement system or calculation method. In our study, we used Star Excursion Balance test(SEBT) which is a promising test of dynamic postural control that may be useful in assessing functional deficits. Completion of the SEBT requires many attributes including strength, flexibility, neuromuscular control, core stability, range of motion, balance and proprioception [19]. Utilizing this test can provide us with objective data for dynamic postural stability evaluation for use in the areas of injury prevention and management, namely assessment, rehabilitation, screening. Each reaching direction offers different challenges and requires combinations of sagittal, frontal, and transverse movements. Earl and Hertel [20] found that muscle activation was substantially different across the various reach directions, activity being higher during the posterior, posterolateral, and lateral excursions than during the anterior and anteromedial excursions. This finding might be helpful to clinicians deciding which reach directions to employ as outcome measures in patients with specific impairments in muscle strength. In our study, it was found that significant differences were seen in medial, lateral, posteromedial directions indicating these directions can be used as an outcome measure to diagnose impairments in ACL with or without meniscal tears. The most important finding of the present study was that postural stability on the affected sides did differ significantly between patients with isolated ACL tears and those with both ACL tears and meniscal tears. This difference was significant clinically in all directions and statistically significant in medial, lateral and posteromedial directions.

Postural stability is decreased to some extent in patients with ACL tears [21], presumably due to disruption of mechanoreceptors within the ligament. That is, a slight decrease in postural stability resulting from a meniscus tear may be masked by the greater reduction resulting from an ACL tear. Thus, postural instability on the affected side may be similar in these two groups of patients.

In our study, postural control was more impaired and slow to recover among patients who had had ACL reconstruction combined with menisectomy compared to patients with isolated ACL reconstructions.

Reduced balancing ability on the affected side was most likely to be caused by deficits due to mechanoreceptor injuries [22]. In the postoperative period, balancing ability increased continuously in both the groups over a period of follow up. This increase was more in isolated ACL group compared to ACL+MM group indicating that patients with combined ACL and medial meniscus tears were less capable of adapting to unidirectional perturbation and had slower recovery in postural stability. Also, the removal of damaged mechanoreceptors in partial medial meniscectomy may reduce balancing capacity. However, Improvement in postural stability did not reach the level of normal unaffected limb, even one year after surgery. This might reflect interference between damaged and healthy mechanoreceptors, which may reduce the overall balancing capacity. From our results it can be inferred that the one-year postoperative period was not enough for the regeneration of

mechanoreceptors in the meniscus and thus special emphasis should be placed on improving both static and dynamic balance when arranging postoperative rehabilitation.

This study had several limitations, one of the most important being the differences in meniscus tear patterns and extent among the subjects studied which was not taken into account. Although the meniscus has receptors in all Cooper zones, the red and red-white zones contain more receptors than the white zone [15]. Therefore, tears involving the peripheral areas may result in injury to more mechanoreceptors, such that postural stability would be poorer in patients with peripheral than inner rim tears.

In addition, only patients with medial meniscus tears were included in the present work to avoid any potential difference in postural stability between patients with medial and lateral meniscus tears. This may have resulted in some selection bias. However, the dominance in this study of patients with chronic ACL tears led to the exclusion of patients with lateral meniscal tears, because medial meniscal tears are more common in patients with chronic than acute ACL tears [23], whereas lateral meniscus tears are more common in patients with acute ACL tears [24]. The last limitation of this research is that electromyographical analysis was not used to determine the response of the muscles surrounding the knee. In further research muscle response could be analyzed.

CONCLUSION

Concomitant menisectomy does affect the recovery of dynamic proprioceptive deficits and the recovery phase is longer after arthroscopically assisted anterior cruciate ligament (ACL) reconstruction compared to ACL reconstruction alone.

Conflicts of interest: **None**

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