Original Research Article *DOI Number: 10.5958/0973-5674.2020.00046.5*

Proprioceptive and Functional Outcome of the Knee in Arthroscopic Anterior Cruciate Ligament Reconstruction of a Preserved Remnant Tissue

Srikanth I[1], Shishir SM[2], Yamamalini S[3], Najimudeen Syed[2]

[1]Associate Professor / In-charge, Department of Physical Medicine and Rehabilitation, [2]Professor, Department of Orthopaedics, [3]Assistant Professor, Department of Physical Medicine and Rehabilitation, Pondicherry Institute of Medical Sciences, Puducherry, India

Abstract

Background: Injury to the ACL(Anterior Cruciate Ligament) not only causes mechanical instability but also leads to functional deficit in the form of diminished proprioception of the knee joint. This study analyzes and reviews our understanding of the sensory element of ACL deficiency, with specific reference to proprioception as an important component of functional knee stability.

Method: 100 patients who underwent ACL reconstruction surgery and completed Simple and Effective Rehabilitation Protocol(SERP) with minimum duration of 2 years from surgery to follow up, were all assessed for proprioception, stability and functional outcome of the reconstructed knee. They were assessed by the knee joint position sense, single leg hop test for both the normal and reconstructed knee and KOOS questionnaire respectively.

Result: Chi square table value for 1degree freedom at 0.05 was 3.84, hence the calculated Chi square values of proprioception knee in supine lying, proprioception knee in standing and single leg hop are less than table value of the accepted hypothesis which concludes that, there is no significant difference between the scores of selected outcome variables among reconstructed knee and normal knee subjects. The calculated paired‘t’ and ‘t’ table value with respect to the functional outcome of knee in operated and normal subjects was 6.53 and 2.66 respectively at 0.005 level.

Conclusion: There was no significant difference of Proprioception between the scores of selected outcome variables among reconstructed knee and normal knee in supine lying, standing and single leg hop. But it shows that there is significant difference of 2.66 at 0.005 level between reconstructed knee and normal knee groups with respect to the functional outcome of knee after two years of follow-up in ACL reconstructed knees.

Keywords: *ACL, remnant tissue, Reconstruction, Joint position sense, Stability, Functional outcome.*

Introduction

Anterior cruciate ligament (ACL) is considered as the proprioceptive sensory organ as well as primary stabilizer of the knee. Due to the proprioceptive ability that helps in initiating the protective and stabilizing muscular reflexes[1]. Any trauma to the ACL can result in compromising the joint afferent sensations resulting in proprioceptive deficits. Therefore, the potential goal of the ACL reconstruction is to restore better proprioception. It is known that the ACL injured knee frequently has a ligament remnant tissue (mostly at the tibial footprint) in which mechanoreceptors and free neural ends are found[2,3].

Corresponding author:
Srikanth I,
Associate Professor / In-charge, Department of Physical Medicine and Rehabilitation, Pondicherry Institute of Medical Sciences, Puducherry, India.
Mobile: 9626915828,
E mail: srikanth19804@gmail.com

Theoretically, there is a strong possibility that the preservation of the ACL remnant tissue may restore proprioception, stability and functional outcome of the graft after ACL reconstruction[4]. In the recent past, the surgical technique that preserves this remnant tissue in arthroscopic ACL reconstruction is known to have shown better preservation of the proprioceptive function[2,5].

The purpose of this study is to evaluate the proprioceptive ability and the functional outcome of the patient who have undergone the remnant tissue preservation arthroscopic ACL reconstruction surgical technique in patients with ACL tears. The research hypothesis was that there was no significant difference between the scores of selected outcome variables among reconstructed knee and normal knee subjects.

Material and Method

The present cross-sectional study was approved by Ethical Committee and Institutional Review Board (RC/16/154). Hundred consecutive patients who underwent the preserved remnant tissue technique ACL reconstruction in our institution and who completed the SERP rehabilitation were included in the study. Minimum duration from surgery to assessment was 2 years. Both men and women with in the age group of 18 – 60 years who underwent surgery and completed SERP protocol of minimum duration from surgery to assessment of 2 years with unilateral ACL reconstruction were included in the study[6]. Patients with re-injury of ACL, revision surgery and those who did not participate or complete the SERP rehabilitation protocol were excluded from the study. The patients were called to the Orthopedic OPD department and evaluated in department of Physical Medicine and Rehabilitation of our institution.

Initially, the patients were given KOOS questionnaire for completion. A translated version in the language of their choice was made available for patients who had difficulty in comprehending the questions[7,8]. Joint position sense was assessed by replicating knee joint angle and was measured with universal goniometer, average of 3 response angles from two different positions; supine and standing with full knee extension was done. Initially, for trial, the patients were asked to bend the knee to 30 degrees of flexion (test angle) with eyes open. Further, for assessment they were asked to close the eyes and bend the knee to test angle. This joint position was measured with goniometer[9]. Same procedure was followed to the normal limb and compared. Stability of the knee was assessed by Single hop test which is reliable and a valid tool to measure the knee[10].A 6 meter distance was measured, a base line was marked where the patients were asked to stand. The subjects were told to hop as far as possible, take off and land on the same foot[11]. The hop distances were measured from toe to toe of same foot. The tests were performed for both legs 3 times each. The patients were given one trial of single leg hop before the readings were taken.

The data were analyzed by SPSS 20.0 through the following statistical analysis. Descriptive statistics Chi square test was used to find the difference between the scores proprioceptive ability in various position and further inferential statistics Unpaired t-test was performed to find the functional outcome scores of KOOS questionnaire among reconstructed knee subjects.

Findings

Table 1 shows the Chi square value of knee joint sense in supine lying was 0.0074 and Chi square value of knee joint sense in standing position was 0.0055. Table 2 shows the Chi square value of Knee joint stability was 0.0057. Chi square table value for 1degree freedom at 0.05 was 3.84, hence the calculated Chi square values of proprioception knee in supine, proprioception knee in standing and single leg hop are less than table value then, the hypothesis is accepted and it was concluded that, there is no significant difference between the scores of selected outcome variables among reconstructed knee and normal knee subjects. Table 3 shows the comparative mean value, mean difference, standard deviation and unpaired ‘t’ values of functional outcome of knee between reconstructed knee and normal knee subjects.

In reconstructed knee and normal knee group subjects for functional outcome of knee the calculated paired ‘t’ value is 6.53 and ‘t’ table value was 2.66 at 0.005 level. Since the calculated ‘t’ value is more than ‘t’ table value, it shows that there was significant difference between reconstructed knee and normal knee group in functional outcome of knee in the follow up two years duration.

Table 1: Chi square value of joint sense of knee in supine lying, standing.

Sl. No.	Variable	Chi square value
1.	Joint sense Knee in supine lying	0.0074
2.	Joint sense Knee in standing	0.0055

Table 2: Chi square value of knee joint stability by single leg hop.

Sl. No.	Variable	Chi square value
1.	Single leg hop	0.0057

Table 3: Comparative mean value, mean difference, standard deviation and unpaired 't' values of functional outcome of knee between reconstructed knee and normal knee subjects.

n = 100

Sl .No	Groups	Functional outcome of knee		Standard deviation	Unpaired "t" test
		Mean	Mean difference		
1	Reconstructed knee	2.29	1.62	0.57	6.53*
2	Normal knee	0.67			

*0.005 level of significance

Discussion

Any trauma to the ACL can result in compromising the joint afferent sensations which in turn may cause proprioceptive deficits. Therefore, the potential goal of the ACL reconstruction is to restore proprioception as close to the native knee as possible[12]. There is a strong possibility that the preservation of the ACL remnant tissue maybe able to restore proprioceptive function of the graft after ACL reconstruction. In the recent past, the surgical technique that preserves this remnant tissue in arthroscopic ACL reconstruction is known to have shown better preservation of the proprioceptive function[13].

Our understanding of recovery of knee function in ACL-deficient knees is still evolving. Although most of the focus today is on anatomic placement, the number and position of various bundles during reconstruction. Enough evidence is coming to light which establishes that proprioception of the knee suffers after an ACL tear. Proprioception is emerging as an important factor to determine post-operative results of ACL reconstruction[14].

Various studies have demonstrated the presence of mechanoreceptors in remnant ACL stumps; based on this there have been proposals of preserving these ACL remnants during reconstruction to ensure a better functional outcome[15]. We believe that proprioception is an important aspect of knee stability, and that it is lost after ACL injury, and all attempts must be made to restore as much proprioception as possible by modifying surgical methods and rehabilitation protocols. Remnant preserving surgery may be one of the options that needs to be explored in more detail, and could potentially be a solution to some of the poor functional outcomes in mechanically well-done ACL reconstructions[3,16].

Takahashi, T et al persevered the ACL remnant tissue in ACL reconstruction which enhanced cell proliferation, revascularization, and regeneration of proprioceptive organs in the reconstructed ACL and reduced anterior translation. However, remnant preservation did not improve the structural properties of the graft[17].

Proprioception contributes to the development of motor control and plays a major role in the reflex

protection of joints against potentially harmful forces, as reduced proprioception is one of the factors contributing to re-injury of the knee. Therefore, proprioception appears not only important for regaining full function after ACL reconstruction but also for the prevention of future ACL injury in a reconstructed knee.

Evaluation of the functional outcomes did not reveal any significant differences in terms of mechanical stability between the two groups. However, a significant difference was detected in functional outcome and proprioception in the two groups with group one (>20% remnant) showing better results. According to Lee BI et al, thus postulated that if more of the tibial stump was kept intact, better would be the preservation of proprioceptive function and the functional outcome for the patient[18].

A detailed analysis of proprioception in normal and ACL-deficient knees was also done by Pap et al. Proprioception was assessed using detection of knee movements in 20 patients with unilateral ACL deficient knees and 15 age-matched control subjects. The authors also found diminished proprioception in knees with ACL tears as compared to the uninjured knees of patients and the control group[19].

According to Zhanget al,ACL remnant tissue harvested within 3 months after injury yields higher healing potential, suggesting that early surgical intervention may achieve better clinical results[20]. MunetaTet al remnant-preserving ACL reconstruction has higher potential for early healing, superior functional recovery, earlier return to sports, and lower occurrence of re-injury, although the scientific evidence to support the potential is not yet sufficient[21].

Kim et al suggested that the remnant – preserving technique could be an effective alternative to traditional techniques. This technique provided comparable mechanical stability and improved proprioception and vascular recovery as compared to remnant shaving techniques[22].

Song et al, had concluded that the mean Coleman Methodology Score showed moderate methodologic quality for the included studies. This systematic review showed significant postoperative improvements in patients undergoing remnant-preserving ACLR in all of the studies. The currently available evidence is not sufficiently strong to support the superiority of remnant-preserving ACLR[23].The authors concluded that ACL remnants of adolescent patients had more CD34+ cells, and those cells had a higher potential for proliferation and multiline age differentiation in vitro. During remnant-preserving or remnant-transplanted ACL reconstruction, surgeons should consider the patient's age when predicting the healing potential[24].

Lee et al concluded that apart from improving proprioception, certain remnant tissues provided mechanical stability to the knee as well[16,20]. Sekiya et al., investigated the significance of the single-legged hop test to the ACL reconstructed knee as it specifically relates to knee muscle strength recovery and residual anterior laxity. Positive correlations were found between the hop index and muscle strength index at all levels of residual anterior laxity ($P < 0.05$), but these correlation coefficients were relatively low[8]. On the other hand, the remnant tissue preservation has been expected to enhance the recovery of proprioceptive sensation[25-27].

In this study there was improvement in proprioception, stability and functional outcome of the knee in arthroscopic ACL reconstructed knees with preserved remnant tissue.

Conclusion

In this study of arthroscopic ACL reconstruction with preserved remnant tissue, proprioception of knee in lying, standing and single leg hop were less than table value of the accepted hypothesis which concludes that, there was no significant difference between the scores of selected outcome variables among reconstructed and normal knee. But it shows that there was significant difference between reconstructed knee and normal knee group in functional outcome of knee at the time of two years of follow up.

Conflict of Interest – Nil

Source of Funding- Self

Ethical Clearance: Ethical clearance was **o**btained from the Institutional Review Board at Pondicherry Institute of Medical Sciences, Puducherry. IRB No. RC/16/154

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