Comparison of Quadriceps Muscle Girth Using Ultrasound Imaging In Supervised vs Unsupervised Post Operative ACL Reconstruction

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Abstract

Injury to the anterior cruciate ligament (ACL) is one of the most common knee ligament injuries. The ACL injury is a sprain or tear of the anterior ligament (ACL). Effective exercises will reduce the risk of ACL injury. An ACL injury in athletes is a higher incidence than other general public, such as soccer, basketball, hockey, etc. The aim of this study was to compare the effectiveness, recovery rate and variance in both knee-affected and non-affected muscle girth readings in supervised v/s unsupervised patient groups after the patient underwent ACL reconstruction surgery. The participants were divided into two groups(A-Supervised and B-Unsupervised) through a random sampling. The supervised exercise in group A performed according to the WILK protocol at RML hospital and un-superviseed group B performed the same WILK protocol at home. The ultrasound scans were performed after 2-4 weeks and 12-14 weeks post operation to measure the muscle girth in both the groups. The study findings indicated the significant difference in recovery rate as well as the difference in between supervised/s unsupervised groups i.e. the difference of affected and unaffected knees based on ultrasound imaging was higher in un-supervised group compared to supervised group (a difference of 2.3 mm in post-operation muscle girth after 12-14 weeks). The ultrasound reading of the muscle girth after 2-4 weeks post-operation showed a decline in the recovery of the muscle girth in both the groups (9% and 8% for supervised and un-supervised groups respectively). This reduction in the muscle girth value as compared to the pre-operative values was due to arthroscopic effect, which showed there was a transient deactivation of the muscle take place due to surgery. The ultrasound reading of the muscle girth after 12-14 weeks post-operation showed a different progressive recovery of the muscle girth in both the groups as 31% and 10% for supervised and un-supervised groups respectively. We concluded that supervised exercises was better than unsupervised exercises for the early recovery after ACL recontraction.

Keywords: Quadriceps; Muscle girth; ACL; Ultrasound; Recovery.

Introduction

The knee is a weight-bearing joint which operates as a fulcrum between tibia and femur. ACL is present in the knee and the bone structure of the knee joint is made up of the tibia, femur and patella. The knee is basically a pivoted joint that is held together by the Posterior Cruciate (PCL) ligaments, Medial Collateral (MCL), Anterior Cruciate (ACL) and Lateral Collateral (LCL). The ACL is located diagonally in the knee as is shown in the below figure, keeping the tibia from sliding out before the femur and also giving rotational steadiness to the knee. The ACL is one of the four primary ligaments inside the knee that associate the femur to the tibia. ACL tends to be at risk as it prevents posterior displacement of the distal femur on the tibia. ACL can tear due to twisting type of force acted at the joint in such
ACL reconstruction may be defined as the functional restoration of the ACL to its native dimensions, collagen orientation and insertion sites. ACL Reconstruction is the technique in which the tunnels are placed in the centre of the native femoral and tibial insertion sites. It can be done either through a single bundle or double bundle. Anatomic ACL reconstruction can be used in both single and double-bundle reconstructions and also to Augmentation surgery. Complete restoration of the native ACL may not be possible, because of the complex nature of the ligament. However, the surgeons always attempt towards close proximity.

ACL injuries received the greater attention of orthopaedic surgeons and due to their deep analysis of the subject, it became possible to treat such injury. Previously, the cases of ACL were not reported so frequently in India as in the current scenario due to the absence of sufficient analytical skills & required tools. But now the incidences of ACL have increased and after an ample amount of research in this field, the surgeons are able to perform ACL Reconstruction successfully. There is as low as 2.5% chance of recurrent instability due to rupture of the reconstructed ligament or maybe poor surgical technique. The post-operative examination was carried out by a non-operative observer. On the first postoperative day, digital anteroposterior and lateral knee radiographs were completed without a strap. For the direction and inclination of the tunnel on the frontal and sagittal planes, the femoral tunnel was evaluated in radiographs. The follow-up was done weekly, then at 2-3 weeks, three months and one year. During 1-year follow-up, a practical performance review was conducted with the Lysholm knee scoring system. A rolimeter (Rolimeter TM for measuring anterior/posterior knee joint laxity by aircraft) was used to assess previous tibial translation quantitatively. Pivot shift testing was performed. The main objective of the study was to compare and to find out the relative progression of muscle girth readings in supervised v/s unsupervised ACL recontraction patient.

**Material and Method**

Eighty-two subjects (73 male 9 female) at the age group of 18-40 yrs were enrolled for this study between November 2016 to December 2018. All the participants had undergone ACL reconstruction surgery at RML hospital Delhi. The selection of participants was volunteered and their consent for performing Ultrasound imaging was provided formally. The participants were divided into two groups as Group A: Supervised and Group B: Unsupervised. The average age of participants in supervised and unsupervised groups were 27.5 and 28.5 years respectively. The inclusion criteria were Post-operative anatomic ACL reconstruction. The exclusion criteria were any degenerative changes, bone infections, any previous injury in lower limb other than an ACL injury, any metabolic disorders like diabetes, obesity...
and hypertension, any meniscal or PCL injury and pre-operative MRI Scan confirming ACL tear only no associated injury to menisci or other ligaments.

**Assessment:** Detail assessment was performed according to the assessment performa measuring the mid thigh circumference and special tests and strength of the muscle. WILK protocol was adopted for the strengthening exercise for both the groups for a duration of 3 months post operative.

**Measurement of quadriceps muscle girth:** Ultrasound is most commonly used in the assessment of soft tissue disease or fluid collection detection and may also be used to visualize other structures, such as cartilage and bone surfaces. All measurements in patients were performed three times: measurements were performed on the Kranzbüchler ultrasound machine, Medizinische Systeme GMBH, Germany, using a 7.5 MHz linear probe (Medizinische). During the measurements, the subjects lay on their backs with stretched/extended legs, their muscles relaxed and their feet in a neutral position. Both legs were examined for both the groups and muscular girth was measured by horizontal and vertical scanning of the upper leg, in the centre of the upper leg and 5 cm proximal and distal from the centre. In their central segments, m. vastus intermedius and m. rectus femoris have square shapes. The reproducibility of the ultrasound procedure was calculated by several measurements of 10 healthy volunteers over one day, as a change in muscle volume can not be predicted in such a short period of time. The error of this process was calculated on the basis of the variations and the uncertainty coefficients of these measurements. Measurement of thigh circumference was usually performed 15 cm proximal to the superior pole of the patella. The thigh circumference was measured in cm with the measuring tape and compared to the normal contralateral knee to determine the amount of quadriceps atrophy present. Measurements for ultrasound scans.

Muscle dimensions were measured on off-line scans using Image J software (available http://rsb.info.nih.gov/ij/docs/index.html). Muscle thickness was measured as the greatest vertical distance between the anterior and posterior borders of RF from their inside edges. Statistical tests: The SPSS 24 (Statistics System for Social Science) was used for statistical analysis. The paired t-test was performed, which was having a significance p-value (less than 0.05).

**Results**

The figure 2 showed the data for supervised and un-supervised groups. The following information was tabulated in the Excel spreadsheets: sex, age, ms mid quad for normal, ms mid quad in pre-operation, ms mid quad in 8 weeks of operation and ms mid quad in 12-14 weeks of operation for both supervised and unsupervised groups. A total of 164 participants were divided into two groups, i.e. 82 in each group. The pre-operative values of muscle girth for supervised was 10.83 mm and for unsupervised was 10.93 mm. The ultrasound reading after 2-4 weeks post operation for supervised group was 9.83 mm and for un-supervised was 10.11 mm respectively. Both the readings of post operative 2-4 weeks, was having a downwards recovery of the muscle girth. The findings of the one pair sample statistics for supervised group is having a mean value for study group is 14.3 mm, for normal/un-effected limb is 15.2 mm. Whereas the standard mean difference of 0.9 mm for three month post operative to normal. Furthermore the standard error value of 0.24 and 0.36 for three month post operative and normal respectively. On the other hand the values for supervised group is having a mean value for study group is 12 mm, for normal/un-effected limb is 15 mm. Whereas the standard mean difference of 03 mm for three month post operative to normal and furthermore the standard error value of 0.29 and 0.38 for three month post operative and normal respectively.
Figure 2: Supervised vs unsupervised ultrasound readings of ACL Reconstruction patients

Discussion

The ultrasound reading of the muscle girth after 2-4 weeks of post-operation showed a decline in the recovery of the muscle girth in both the groups (-9% and -8% for supervised and un-supervised groups). This reduction in the muscle girth value as compared to the pre-operative values was due to arthroscopic effect, which showed there was a transient deactivation of the muscle which took place due to surgery\(^1\). The ultrasound reading of the muscle girth after 12-14 weeks post-operation showed a significant progressive recovery of the muscle girth in both the groups (31% and 10% for supervised and un-supervised groups respectively). This progression in the muscle girth value as compared to the pre-operative values (the difference between the progression in the two group) is significant (21%), is due to the approach in supervised exercise vs un-supervised exercise, where the focus is for isolated muscle activation of the knee. The statistical data analysis provided a comprehensive understanding of the gain in the muscle girth and the data would be inferred that the recovery rate in supervised group is relatively approaching towards the normality, whereas in the un-supervised group the difference in the affected and normal is relatively higher i.e. it is deficient of recovery of muscle strength post operatively. It was also observed that in the unsupervised group, the muscle atrophy was very significantly visible in comparison with the supervised group. Furthermore it was also observed that the functional strength required post operatively for the knee was lacking in the unsupervised group\(^8,10,31–33\). This study also reflected the importance and the significance of the exercise done under supervision where the physiotherapist and the patient could adopt focused approach to develop the required muscle strength and substitution of the other muscles groups could be avoided, which was lacking in the unsupervised group, where patients are complying with the exercise protocol but unable to discriminate the muscle group to be strengthened and using the gross muscles for the thigh leading to the imbalance of the muscle strength between the agonist and the antagonist group i.e. knee extensors and knee flexures muscles\(^5\).

Conclusion

With the above study the authors concluded that supervised exercises in post operative ACL reconstruction plays a very significant role for the recovery and also reduces the chances of post operative complications remarkably.
**Ethical Clearance:** Taken from the ethical committee of post graduate institute of medical education & research, Dr. Ram Monohar Lohia Hospital, New Delhi approved the study.

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**Conflict of Interest:** Nil.

**References**


