



Impact Of Russian Current Combined With Close And Open Kinetic Chain Strengthening Exercises On ACL Revision Reconstruction Using Allograft - A Case Report

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ARTICLE INFO

ABSTRACT

Introduction: Primary anterior cruciate ligament (ACL) restoration has been found to be a successful intervention with majority of patients experiencing functional recovery and good to exceptional clinical results in post-operative evaluations. Appropriate physiotherapy management is pivotal in the post-reconstruction phase to lower the risk of problems such as edema, pain, decreased joint range of motion, muscular weakness, muscle girth, poor balance and impaired functional activity.

Method: A 23-year-old recreational football player with post-surgical case of recurrent left ACL reconstruction came to sports physiotherapy department for rehabilitation. The recurrence was managed by arthroscopic ACL revision reconstructive surgery using tibialis posterior allograft. In this case study, we evaluated the patient's pain, range of motion, strength of the muscles and muscles girth. In adherence to ACL rehabilitation protocol, we used Russian current combined with various closed and open kinetic chain exercises for improving range, thigh and leg muscles girth and also for improving the strength of thigh muscles. We also provided MFR to the lower limb muscles every alternate day, with patellar mobilization to increase range of motion along with strengthening of hamstring, quadriceps and calf. After that we used vigorous lower limb and core strengthening program with balance and proprioception training along with agility and plyometric training.

Result: We compared the pain, range of motion, strength and muscles girth before and after rehab and found a significant improvement after 6 months.

Conclusion: Application of Russian current was effective for pain reduction and helped in strengthening of the muscles up-to four weeks. We initially used closed kinetic chain strengthening exercises for first two weeks followed by open kinetic chain strengthening exercises, in further progression vigorous strengthening and endurance training of lower limb and core muscles, balance and proprioception, agility and plyometrics training provided a patient very good recovery and improvement in overall functional capacity of the patient after 6 months of rehabilitation.

Keywords: ACL revision reconstruction, allograft, Russian current, open kinetic chain exercises, closed kinetic chain exercises.

INTRODUCTION

Primary anterior cruciate ligament (ACL) restoration has been found to be a successful intervention, with majority of patients experiencing functional recovery and good to exceptional clinical results in post-op evaluations. Although, it has been observed that the professional footballers can rejoin their sport following

the reconstructive surgery, only 67% of them were capable of competing at the highest level, 3 years following the operation. Additionally, contralateral ACL tears are infrequently found in the literature. It is to be noted that the first two years after an ACL reconstruction are crucial, as ipsilateral graft failure is most likely to happen during this period [1]. The prevalence of a third ACL injury in the general population ranges from 4 to 13%. To enhance functional results and regain joint stability, an ACL repair is advised [1]. According to reports, there are 36.9 to 60.9 anterior cruciate ligament (ACL) ruptures per million person-years, 10 to 20% of which are repeat rupture [2].

Allograft tissue has come to be accepted as a viable alternative for use in revision surgery, but concern still exist regarding the potential dangers over the advantages of this approach. As long as the tissue is not radioactively treated, or is only minimally treated, a safe and more reliable choice for revision ACL restoration is the use of these allograft tendons which has a comparable failure rate to autografts and no increased risk of infection. These situations wherein revision surgery is involved, using autografts further, could result in increased morbidity at donor site with additional instability issues especially in cases where new structures may need to be rebuilt, with evidence of autologous tendon degeneration. Allograft tissues can be viewed as a good choice for this purpose, in light of the most recent evidence. A surgeon must choose the most appropriate solution for problematic knee joint which is undergoing the revision ACL repair [3].

Following is a case study of 23year old recreational footballer who is returning to activities of daily living after revision ACL surgery. This study has been presented as a Scientific paper and the Abstract is under publication process at 3rd BRICSCESS Conference, MRIIRS, Delhi NCR, India.

PRESENTATION OF CASE

A male recreational footballer aged 23 years came to Sports OPD for post-surgical rehabilitation of left ACL reconstruction. In the past, athlete already endured injuries to ACL twice on the left side which is the ipsilateral side and once contralaterally as well. The first and foremost ACL tear took place when the athlete was 18 years old and he underwent ACL reconstruction with lateral meniscus repair, wherein a same side autograft from hamstring (gracilis and semitendinosus tendon) was taken. The player returned to sports after 6 months. A year later, this was followed by another injury to ACL ligament on the right side. The graft used was similar to the previous surgery and another 6 months were required by the athlete to return to sports. Third episode of injury occurred to the ACL ligament on left side (2nd time on same side) and happened when he was 21 years old. An arthroscopic ACL revision was performed using tibialis posterior allograft + notchplasty + meniscectomy (partial lateral), trimming and balancing + Medial Femoral Condyle (MFC) bone marrow stimulation (BMS) + lateral extra articular tenodesis (LET) was done.

Magnetic resonance imaging displayed rupture of the graft of ACL, resulting in the typical anterior translation of the tibial proximal part as compared to the distal portion of femur. It was a complex tear as it involved the medial meniscus's posterior horn including the posterior root attachment. Focal chondral defect was seen in the adjacent inferior articular surface of the medial femoral condyle, on the posterior aspect. In posteromedial corner of knee, a ruptured Bakers cyst was seen, with fluid tracking inferiorly in the medial aspect of the proximal leg. The craniocaudal dimensions of the Bakers cyst were 4.2 cm. The superficial medial collateral ligament was seen to be intact.

Altered morphology and signal of the lateral meniscus is concerning for a re-tear rather than the postoperative change. Focal chondral defect seen at the medial patellar facet. Structures of the posterolateral corner including the intraarticular popliteus tendon, fibulae collateral ligament and tendon of biceps femoris are intact. Iliotibial band is also intact. PCL is intact. Tendons of quadriceps and patella are normal. Rest of the patellofemoral articulate cartilage is fairly well preserved. Large joint effusion is seen with fluid in the patellofemoral recesses.

SURGICAL HISTORY

For surgery, patient was in supine position with a leg holder. Notchplasty was done for the noted narrow femoral notch. Anterior cruciate graft tear was noted, tibial and femoral tunnels were prepared, previous graft and sutures were then removed. ACL Reconstruction was done with tibialis posterior allograft (MTF). Femoral tunnel of 10 mm was fixed with tightrope RT and tibial tunnel of 10 mm was fixed with Biosure HA screw 11 x 35mm.

Lateral extra articular tenodesis was performed using central 1cm strip of ITB, passed beneath LCL and fixed in the femur with healicoil PK 4.5 suture anchor and ITB tightening was then done. Complete meniscal loss was observed in medial meniscus's posterior horn. Bucket handle tear was spotted in posterior horn extending to the body, in the 2/3 zone – the Avascular irreparable zone for which trimming and balancing was done. Sutures of previous failed repair were also noted. MFC grade ¾ geographical chondral wear was noted – BMS was done. Rest of the joint was normal.

Post Surgery, special instructions were given by surgeon including NWB x 1 week, PWB x 1 week, FWB x 1 week.

After this protocol, patient came to MGM Sports physiotherapy department for rehabilitation with the chief complaints of pain on anterior aspect of knee, difficulty in knee bending and walking and performing activities of daily living. Patient was assessed on 14/03/2023.

PRE-REHAB PHYSICAL EXAMINATION

Examination started with:

1. Pain testing
2. Range of Motion (ROM) assessment
3. Strength testing
4. Muscle girth evaluation

1	Pain	Rating	Difference between affected and non-affected extremities	
	NPRS	5		
2	ROM	Range in degrees		
		Right	Left	
	Knee Flexion	125	30	95
	Knee Extension	0	0	No difference
3.	Strength	Kg		
		Right	Left	
	Knee Flexors	12	2	10
	Knee Extensors	11.5	2	9.5
4.	Muscle Girth	Cm		
		Right	Left	
	Above knee 3"	44	40	4
	Above knee 6"	54	50	4
	Above knee 9"	62	60	2
	Below knee 6"	35	34.5	0.5

PROTOCOL

ACL Reconstructive Surgery with Allograft Rehabilitation Protocols (Weeks 4-8)				
Weeks	Electrotherapy/ Thermotherapy	Manual therapy	Exercise therapy	Aerobic training
4	Russian Current Dosage: Ramp 1 sec, on 4 sec Off 9 sec Burst 40, PPS for 10 minutes Icing for about 10 minutes.	Patellar mobilization grade 2 Scar (of stitches) mobilization	Static exercises for - quadriceps, hamstring, glutes, back, and abdominals Dosage: 10-sec hold, 10 reps, 2 sets SLR supine with brace locked in full Dosage: extension 2 sets 10 reps Multiple angle isometrics at 30, 60, 90 degrees of knee flexion. Dosage: 10 reps, 2 sets, 5-sec hold	
5	Russian Current Dosage: Ramp 1 sec, on 4 sec Off 9 sec Burst, 60 PPS for 10 minutes	Myofascial release for Quadriceps, Hamstring and calf muscles alternate days Scar (of stitches) mobilization twice weekly	Multiple angle isometrics continued. Heel slides pain-free range Dosage: 2 sets 10 reps Prone hangs. Dosage: 5sec hold 10 reps Pelvis and trunk stabilization exercises grade 1. Dosage: 2 sets of 10 repetitions.	Walking 1 min (with hinge knee brace)
6		Myofascial release for Quadriceps, Hamstring and calf muscles twice weekly. Scar (of	With continuation of previous weeks exercises, Mini squats- Initially up to 20-30 degrees using body weight. Dosage: 2 sets of 10 repetitions. VMO training on VMO board. Dosage: 2 sets of 10 repetitions	Walking 2 minutes (with hinge knee brace)

		stitches) mobilization twice weekly	Ankle plantar flexion and dorsiflexion with purple theraband. Dosage: 2 sets of 10 repetitions Pelvis and trunk stabilization exercises grade 2. Dosage: 2 sets of 10 repetitions.	
			Mini squats-upto 30-45 degrees using body weight. VMO training on VMO board. Dosage: 2 sets of 14 repetitions SLRs in all four planes with locked knee brace in extension. Dosage: 2 sets 10 reps Bridging. Dosage: 2 sets of 10 repetitions Hamstring curls. Dosage: 2 sets of 10 repetitions Pelvis and trunk stabilization exercises grade 3. Dosage: 2 sets of 10 repetitions.	Walking 2 minutes with hinge knee brace) Stationary cycling 5 min
8			Squats-up to 60 degrees using body weight. Dosage: 2 sets of 10 repetitions SLRs in all four planes . Dosage: 2 sets 10 reps Resisted bridging with theraband.Supine and prone. Dosage:2 sets of 10 repetitions Pelvis and trunk stabilization exercises grade 4. Dosage: 2 sets of 10 repetitions. Lunges 30 to 45 degrees (with hinge knee brace) Dosage: 2 sets 10 reps Calf raises. Dosage: 2 sets of 10 repetitions (with hinge knee brace)	Walking 2 minutes (with hinge knee brace) Stationary cycling 6 minutes with minimal resistance

ACL Reconstructive Surgery with Allograft Rehabilitation Protocols (Weeks 9-12)

Weeks	Strengthening	Balance	Aerobic training
9	Lunges 30 to 45 degrees. Dosage: 2 sets 10 reps Total body resistance squats upto 60 degrees. Dosage: 2 sets of 10 reps Calf raises.Dosage: 2 sets of 10 repetitions Total body resistance mini squatsupto 20-30 degrees with ankle plantarflexed. 2 sets of 10 reps Single limb bridging. Dosage: 2 sets of 10 repetitions Pelvis and trunk stabilization exercises grade 5. Dosage 2 sets of 10 repetitions.	Double limb stance with eyes closed. Dosage: 2 sets of 10 repsinitially for 30 sec and progressed to 1 minute	Walking 2 minutes (with hinge knee brace)Stationary cycling 6 minutes with minimal resistance

10	Total body resistance squats upto 60 degrees. Dosage: 2 sets of 10 reps Single limb bridging. Dosage: 2 sets of 16 repetitions Resisted calfraises (with 5 to 15 kg Dumbbells in hand) with a hinge knee brace. Dosage: 2 sets of 10 reps Single limb bridging. Dosage: 2 sets of 16 Pelvis and trunk stabilization exercises grade 6. Dosage 2 sets of 10 repetitions.	Single leg stance with eyes open initially for 30 sec and progressed to 1 min and then eyes closed progression similar to eyes open of 3 sets. Perturbations: initially anticipated then unanticipated and progressed to low and high magnitude and speed respectively.	Walking 2 minutes (with hinge knee brace) Stationary cycling 8 minutes with minimal resistance
11	Total body resistance squats upto 60 degrees. Dosage: 2 sets of 10 reps Core Strengthening exercises: abdominal curls. Dosage: 2 sets of 10 reps Single-leg mini squats up to 20-30 degrees. Dosage: 2 sets of 10 reps Resisted hip abduction and extension in standing. Dosage: 2 sets of 10 reps	Single leg stance with eyes open initially for 30 sec and progressed to 1 min and then eyes closed progression similar to eyes open of 5 sets. Perturbations: initially anticipated then unanticipated and progressed to low speed.	Walking for 1 min Stationary cycling 10 minutes with minimal resistance
12	Total body resistance squats upto 90 degrees. Dosage: 2 sets of 10 reps Single-leg mini squat up to 45-60 degrees. Dosage: 2 sets of 10 reps Resisted hip abduction and extension in standing. Dosage: 2 sets of 10 reps Resisted lateral holds Dosage: 2 sets of 10 reps Alternating lunge holds 30-120 sec hold 2 to 4 sets	Single leg stance with eyes open initially for 30 sec and progressed to 1 min and then eyes closed progression similar to eyes open of 5 sets. Perturbations: initially anticipated then unanticipated and progressed to high magnitude and speed respectively.	Walking for 3 min Stationary cycling for 10 min with moderate resistance

ACL Reconstructive Surgery with Allograft Rehabilitation Protocols (Weeks 13-16)

Weeks	Strengthening	Balance	Proprioceptive training	Aerobic training
13	Single-leg mini squat up to 45-60 degrees. Dosage: 2 sets. 10 reps Total body resistance squats 30-120 sec hold. Dosage: 2-4 sets of 15 to 20 reps Resisted hip abduction and extension in standing. Dosage: 2 sets of 16 reps Alternating lunge holds. Dosage: 30-120 sec hold 6-8 sets	Standing on the BOSU ball eyes open. Dosage: 30 sec to 1 min. 3 sets Standing on BOSU ball eyes closed. Dosage: for 10 sec to 1 min. 3 sets	One-legged stance with the knee flexed. Step out on the other leg with the knee flexed and keep the balance for 5 seconds. 2 sets 10 reps One-legged stance with the hip and knee flexed. Step out on the other leg with the hip and knee flexed and keep the balance for 5 seconds. 2 sets 10 reps.	Initiate walk without brace for 30 sec Stationary cycling for 12 min with moderate resistance
14	With previous weeks exercise, Single-leg mini squat up to 60-90 degrees. Dosage: 2 sets 10 reps. Alternating lunge holds. Dosage: 30-120 sec hold 8-10 sets	Single limb standing on BOSU ball with eyes open. Dosage: for 30 sec to 1 min. 3 sets Single limb standing on BOSU ball with eyes	One-legged stance with the knee flexed. Step out on the other leg with the knee flexed and keep the balance for 5 seconds. 2 sets 10 reps One-legged stance with the hip and knee flexed. Step out on the other leg	Initiate walk without brace for 1 min Stationary cycling for 12 min with moderate resistance

		closed. Dosage: for 10 sec to 1 min .3 sets	with the hip and knee flexed and keep the balance for 5 seconds. 2 sets 10 reps	
15	<p>Single-leg mini squat up to 45-60 degrees. Dosage:2 sets.10 reps</p> <p>Total body resistance squats 30-120 sec hold. Dosage: 2 to 4 sets of 15 to 20 reps</p> <p>Resisted hip abduction and extension in standing. Dosage:2 sets of 16 reps Alternating lunge holds. Dosage:30-120 sec hold 6-8 sets</p>	<p>Standing on the BOSU ball eyes open. Dosage: 30 sec to 1 min. 3 sets</p> <p>Standing on BOSU ball eyes closed. Dosage: for 10 sec to 1 min. 3 sets</p>	<p>One-legged stance with the knee flexed. Step out on the other leg with the knee flexed and keep the balance for 5 seconds. 2 sets 10 reps</p> <p>One-legged stance with the hip and knee flexed. Step out on the other leg with the hip and knee flexed and keep the balance for 5 seconds. 2 sets 10 reps</p>	<p>Initiate walk without brace for 30 sec</p> <p>Stationary cycling for 12 min with moderate resistance</p>
16	<p>With previous weeks exercise, eccentric strengthening started. Quadriceps targeting squats. Dosage:5reps 2sets</p> <p>Nordic Hamstring Curls. Dosage:5reps 2sets</p>	<p>Single limb standing on BOSU ball with eyes open. Dosage: for 1 min. 5 sets</p> <p>Single limb standing on BOSU ball with eyes closed. Dosage: for 30sec to 1 min .3 sets</p>	<p>One-legged stance with the knee flexed. Step out on the other leg with the knee flexed and keep the balance for 5 seconds. 2 sets 10 reps</p> <p>One-legged stance with the hip and knee flexed. Step out on the other leg with the hip and knee flexed and keep the balance for 5 seconds. 2 sets 10 reps.</p>	<p>walk without brace for 2 min</p> <p>Stationary cycling for 14 min with moderate resistance</p>

ACL Reconstructive Surgery with Allograft Rehabilitation Protocols(Weeks 17-20)

Weeks	Strengthening	Balance	Proprioception Training	Aerobic	Agility	Plyometrics
17-18	<p>Quadriceps targeting squats. Dosage:2 sets.10 reps</p> <p>Nordic Hamstring Curls. Dosage:2 sets.10 reps</p>	<p>Squats on the BOSU ball eyes open. Dosage: 2 sets 10 reps</p> <p>Double limb stance on wobble board eyes open. Dosage: 10 sec to 1 min</p> <p>Single limb stance on wobble board with eyes open. Dosage:10 sec to 1 min</p>	<p>Advance Proprioception training</p> <p>continue with previous phase exercises</p> <p>One-legged stance on the foam pad with the knee flexed and progressed on the BOSU ball. Maintain balance for 30 seconds and change stance leg. Repeat twice for both legs.</p>	<p>walk without brace for 3 min</p> <p>Stationary cycling for 14 min with moderate resistance</p>	<p>Three cone drills. Dosage: 5 reps 3 sets</p> <p>Ladder training-front and lateral. Dosage: 2 reps 2 sets</p>	<p>Kicking a ball. Dosage: 2 sets 10 reps</p>
19	<p>Unilateral pelvic bridging on an unstable surface with the ball in hand. Dosage:2 sets.10 reps</p>	<p>Squats on the BOSU ball eyes closed. Dosage: 2 sets 10 reps</p> <p>Double limb</p>	<p>One-legged stance on the foam pad with the hip and knee flexed. Maintain balance for 30 seconds and</p>	<p>Walk for 3-5 min. Stationary cycling for 16 min with moderate</p>	<p>Three cone drills. Dosage: 5 reps 3 sets</p>	<p>Sit to stand from a ball. Dosage: 2 sets 10 reps</p> <p>Side-to-side shuffle</p>

	<p>Unilateral wall slides. Dosage:2 sets.10 reps</p> <p>Step up and step down with a hinge knee brace on. Dosage:2 sets.10 reps</p>	<p>stance on wobble board for 10 sec to 1 min eyes closed.3 times</p> <p>Single limb stance on wobble board with eyes open. Dosage: 10 sec to 30 sec,3-5 times</p>	<p>change stance leg. Repeat twice for both legs.</p> <p>Dribbling of basketball in squat position 40 dribbles.2 sets.</p> <p>Throwing and catching of basketball on BOSU ball. Dosage: 20 catches.2 sets.</p>	resistance	<p>Ladder training-front and lateral. Dosage: 2 reps 2 sets</p>	<p>Dosage: 2 sets 10 reps</p>
20	<p>Unilateral pelvic bridging on an unstable surface with the ball in hand Dosage:2 sets.10 reps</p> <p>Unilateral wall slides. Dosage:2 sets.16reps</p> <p>Step up and step down with a hinge knee brace on. Dosage:2 sets.16 reps</p> <p>Jogging in place with sport card-pulling from the variable direction. Dosage: 30 sec</p>	<p>Squats on the BOSU ball eyes closed. Dosage: 16 reps 2 sets</p> <p>Double limb stance on wobble board eyes closed. Dosage:1 min .5-6 times</p> <p>Single limb stance on wobble board with eyes open. Dosage:1 min .5-6 times</p>	<p>Tandem walking initially and progressed to heel-to-toe tandem walking and then brisk tandem walking for 30 sec to 1 min</p> <p>High-speed step-up and step-down drills. Dosage: 2 sets 10 reps</p>	<p>Walk for 3-5 min. Stationary cycling for 16 min with moderate resistance</p>	<p>Ladder training-front and lateral. Dosage: 2 reps 2 sets</p> <p>A figure of 8 drills dosage: 2reps .2sets</p>	<p>Sit to stand from a ball. Dosage: 2 sets 10 reps</p> <p>Side-to-side shuffle Dosage: 2 sets 10 reps</p>

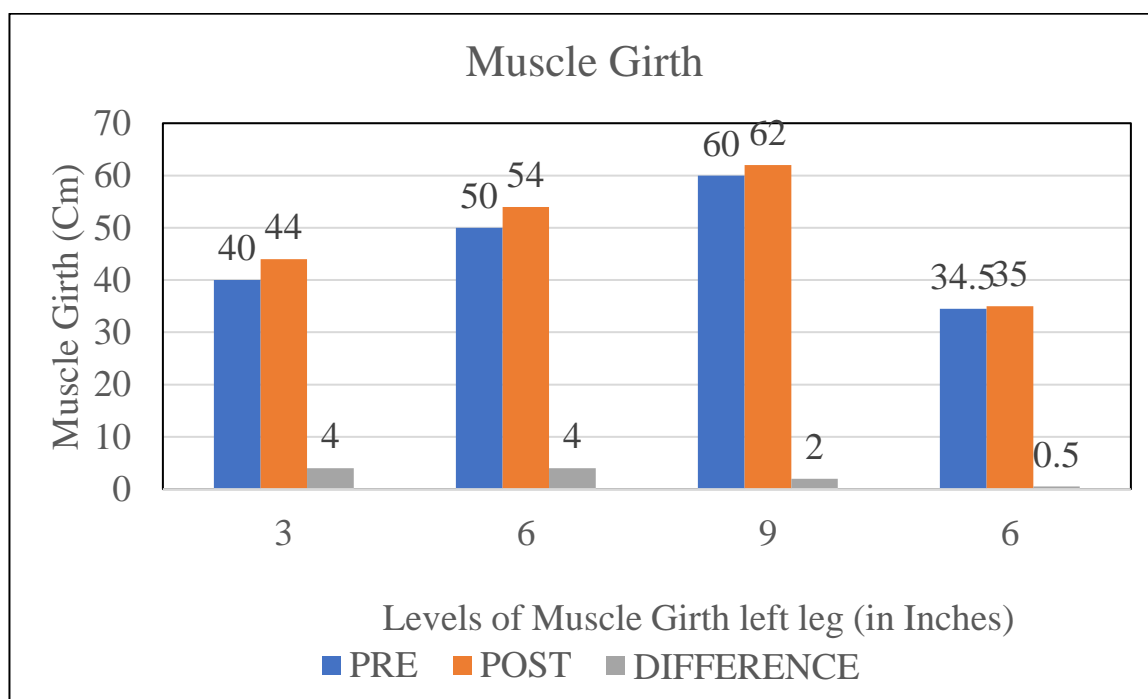
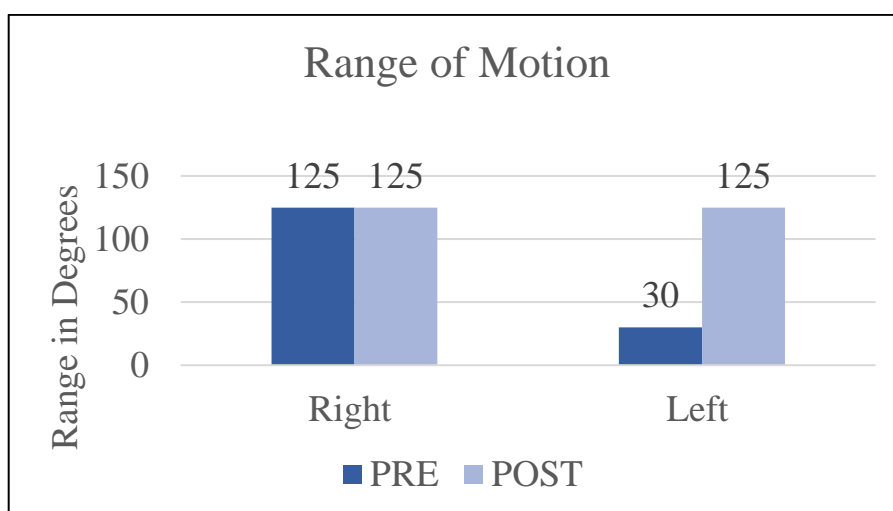
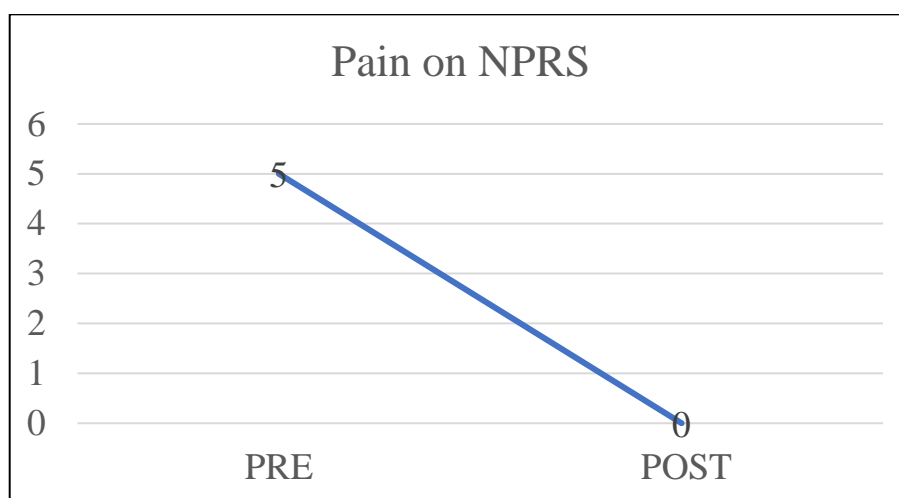
ACL Reconstructive Surgery with Allograft Rehabilitation Protocols(Weeks 21-24)					
Weeks	Strengthening	Balance	Aerobic	Agility	Plyometrics
21	Continued with previous weeks strengthening exercises with increasing repetitions and sets	<p>Single limb stance on wobble board with eyes open. Dosage:1 min .5-6 times.</p> <p>Deep forward lunges. Dosage: 10 to 20 reps 2 sets initially without resistance progressed to resistance.</p> <p>multidirectional lunges on a star pattern on the floor.</p>	<p>Brisk Walk for 3 min.</p> <p>Stationary cycling for 18 min with moderate resistance</p>	<p>Ladder training-front and lateral and back. Dosage: 2 reps 2 sets</p> <p>A figure of 8 drills. Dosage: 3 reps .2sets</p> <p>Side shuffle and freeze drills Dosage: 2 sets 10 reps</p>	<p>Squat jumps. Dosage: 2 sets 10 reps</p> <p>Bounding. Dosage: 3 reps 2 sets</p> <p>Four quadrants jump Dosage: 6 reps 2 sets</p>

		Dosage: 2 sets of one complete round			
22-24	Jogging in place with sport card-pulling from the variable direction. Dosage: 45 sec to 1 min	Single limb stance on wobble board with eyes close. Dosage: 1 min .6 -8 times. Deep forward lunges. Dosage: 10 to 20 reps 2 sets initially without resistance progressed to resistance. multidirectional lunges on a star pattern on the floor. Dosage: 2 sets of one complete round	Jogging and progressed to running 3-5 min Stationary cycling for 20 min with moderate resistance	Side shuffle and freeze drills Dosage: 2 sets 10 reps Ladder training-front and lateral and back Dosage: 3 sets 10 reps Figure of 8 drill. Dosage: 3 sets 3 sets	Squat jumps. Dosage: 14 reps 2 sets Bounding. Dosage: 5 reps 2 sets Four quadrants jump Dosage: 2 sets 10 reps

POST-REHAB PHYSICAL EXAMINATION

1	Pain	Rating		Difference
	NPRS	0		
2	ROM	Range		
		Right	Left	
	Knee Flexion	125	125	
	Knee Extension			
3.	Strength	Kg		
		Right	Left	
	Knee Flexors	13	13	
	Knee Extensors	13.5	13	0.5
4.	Muscle Girth	Cm		
		Rt	Lt	
	Above knee 3"	44	44	
	Above knee 6"	54	54	
	Above knee 9"	62	62	
	Below knee 6"	35	35	

RESULTS



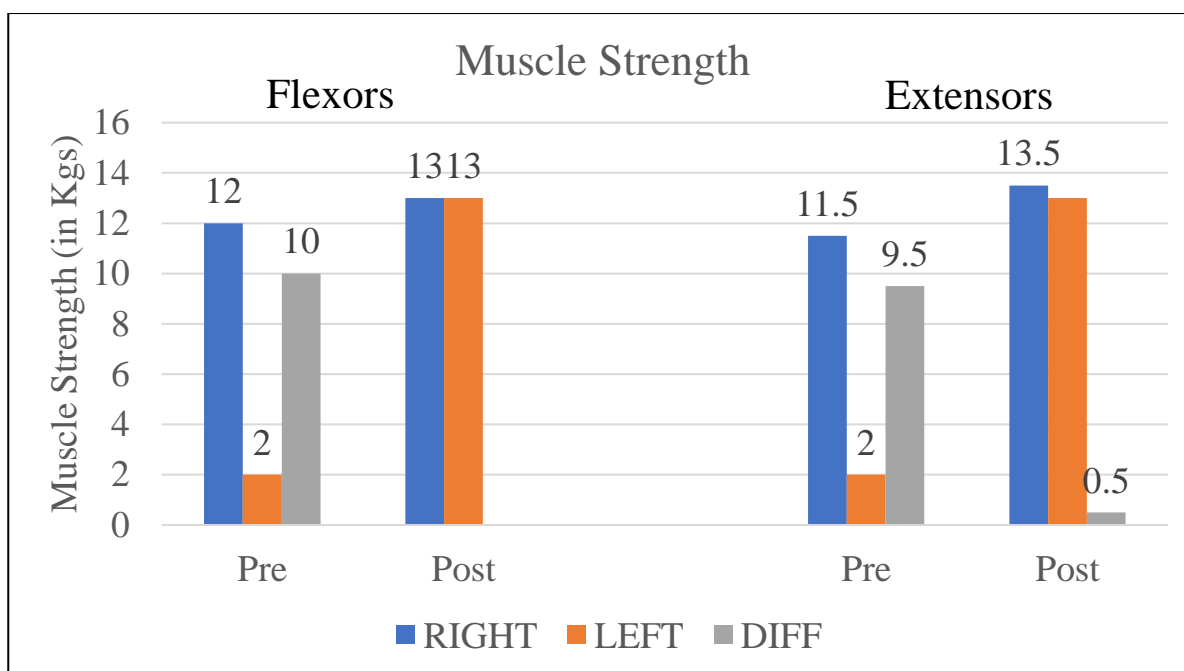


Fig 1:- Strength testing



Fig 2: Strength testing



Fig 3: Russian Current



Fig 4: Range of Motion Measurement

DISCUSSION

In order to reduce pain and inflammation and regain functional range of motion, a specialized rehabilitation program is necessary for a successful ACL repair which will provide monumental help in smooth participation in everyday activities and sports, and restore the previously comparable quality of life.

The results of this study depicted that Russian current combined with closed and open kinetic chain strengthening exercises with progressive resistance exercise of lower limb and core muscles, endurance training of muscles, balance, proprioception, agility and plyometric training was beneficial for improving knee flexion range, the size of thigh and leg muscles, and strength of quadriceps and hamstring muscles and overall functional capacity of the patient was improved.

Ucar, Mehmet Ali et al. conducted a study and concluded that CKC exercises are superior to OKC exercises for mobilisation following ACL surgery, allowing for a speedier return to everyday activities and sports [4]. As reported by Buckthorpe et al., 2019, the quadriceps muscle force and PFJ stress are seen to be at its highest point during OKC movements like knee extensions. On the other hand, the quadriceps muscle force and PFJ stress are highest during CKC activities like lunges and the leg press, close to full flexion. This is the proposed mechanism of effectiveness of CKC over OKC training [5].

Nadeem, Nimra et al. performed a randomised controlled trial with 36 patients, wherein each group was sub-divided into three groups and treated for 6 weeks with conventional treatment using closed kinetic chain exercises, conventional treatment using open kinetic chain exercises, and conventional treatment using RICE therapy respectively. They came to the conclusion that the group with closed kinetic chain exercises showed significant improvement and thus, these exercise are unquestionably superior to operations in terms of improving quadriceps strength and functional status [6].

A review by Michael D. Ross et al., on closed and open kinetic chain exercise implementation after ACL reconstruction brought forth the conclusion that following ACL reconstruction, both aforementioned exercises in the review could safely be used in the initial stages of a rehabilitation programme for specifically working quadriceps strength by usage of certain biomechanics of knee joint. Athletes should refrain from using more extended knee postures for OKC quadriceps workouts and more flexed knee positions for CKC activities. The authors also advised the patients to focus on practising OKC exercises that will help patients achieve volitional quadriceps control in the early stages following ACL surgery. Patients should advance to CKC exercises that can help with muscle recruitment and co-contractions that mimic functional activity as their volitional quadriceps control gets better. Furthermore, ACL damage and reconstructive surgery may have negatively impacted balance and neuromuscular control processes, which can be restored with CKC exercises. However, it has been observed that the normal motions of knee joint, that requires adequate recruitment and activation of quadriceps during CKC exercise, may get hampered by the inevitable occurrence of reflex muscle atrophy of the quadriceps brought on by the effusion and discomfort associated with ACL reconstructive surgery, allowing functional impairments and quadriceps weakness to continue. Because OKC quadriceps exercises isolate weak quadriceps muscle, they should still be a part of the rehabilitation programme following ACL repair, even though the focus may later move to CKC activities [7].

Amr Almaz Abdel-aziem and colleagues concluded in their study that the application of Russian current stimulation in addition to traditional physical therapy increased the quadriceps muscle peak torsion [8].

Our outcomes were in agreement with those of Maffiuletti et al. It was his study that discovered, short-term electrostimulation increases maximal voluntary strength by almost 12% and this was accompanied by neural adaptations (including increased muscle activation and the cross-educational effect) and muscular adaptations in healthy individuals [9]. Similar findings were made by Vaz et al., who discovered that both the low frequency current and Russian current may raise the maximal extensor peak torque of the quadriceps muscles [10].

Furthermore, Snyder- Mackler et al. examined the effects of electrical stimulation and voluntary exercises on muscular strength following anterior cruciate ligament replacement. Exercise and stimulation groups engaged in quadriceps and hamstring co-contraction, with a 15 second hold and then a 50 second rest. The Russian current stimulation group's findings in terms of increased muscular strength were noticeably superior to those of the exercise group [11]. Thiago Yukio Fukuda et al. conducted a study on 30 male subjects where each participant received three currents: two low (50 Hz) frequency currents, one without an intrapulse interval (FES), the other with an intrapulse interval of 100 s (VMS), and a medium frequency (2500 Hz) Russian Current modulated in low frequency. The quadriceps' maximal voluntary isometric torque (MVIT) was determined. While using the three different forms of NMES, the MEIT, pain level, and the highest intensity attained were also recorded. They came to the conclusion that the maximal electrically induced torque while using Russian Current, FES, and VMS was the same. However, compared to low frequency currents, the Russian Current has a better subject tolerance to higher intensities and causes less pain [12, 4].

ACL damage and reconstructive surgery negatively impacts balance and neuromuscular control processes, so we restored with that with balance and proprioception training and further improvement was achieved by agility and plyometric training.

CONCLUSION

Thus, we report a case study of an athlete who is a recreational footballer and underwent a revision reconstruction of ACL of left knee with allograft, and after that underwent a 6 months of ACL rehabilitation programme. In this patient, application of Russian current was effective for pain reduction and helped in strengthening of the muscles initially with closed kinetic chain strengthening exercises combined with open kinetic chain strengthening exercises, in further progression vigorous strengthening and endurance training of lower limb and core muscles, balance and proprioception training with agility and plyometrics training provided a patient very good recovery and improvement in overall functional capacity of the patient after 6 months of rehabilitation.

ADDITIONAL INFORMATION

Disclosures

Human subjects: Consent was obtained or waived by all participants in this study. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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