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COMPARATIVE STUDY BETWEEN MANUAL THERAPY COMBINED WITH EXERCISE AND RUSSIAN CURRENT MODALITY COMBINED WITH EXERCISE IN NON-SURGICAL ACL REHABILITATION

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Abstract

Background: Injury to the ligament (tears and sprain) particularly the ACL are common in active individuals. Anterior cruciate ligament is an important intra-articular ligament of the knee joint because it resists anterior tibial translation and rotational stress. The anterior cruciate ligament (ACL) originates from the medial and anterior aspect of the tibial plateau and runs superiorly, laterally, and posteriorly toward its insertion on the lateral femoral condyle. Anterior cruciate ligament (ACL) injuries are notably frequent and severe, particularly in the context of athletic activities. These injuries typically result in joint swelling, compromised movement mechanics, muscle weakness, and diminished functional capabilities. In this study Manual therapy and electrotherapy(Russian Current) with combined exercises programe has been introduce to reduce and improve function in non surgical ACL rehabilitation.

Objective: The objective of the study is to i) Assess the efficacy of manual therapy in rehabilitation to improve pain and disability in the treatment of non operative ACL rehab, ii) assess the efficacy of electrotherapy (Russian current) in rehabilitation to improve pain and disability in the treatment of non operative ACL rehab,iii)assess the effectiveness of exercise in rehab to improve gait, strength and balance in the treatment of non operative ACL rehab,iv)Finally, the study will compare the results of both intervention strategies in terms of improving dynamic knee function in individuals diagnosed with ACL TEAR or injury.

Methods: 60 patient diagnosed with the ACL tear or injury by orthopedic OPD or physiotherapy department were initially assessed for the inclusion or exclusion criteria. Prior to the treatment procedure patient are oriented to the study. Participants are divided into 2 groups and both groups assessed for the pre test parameter.

Outcome measure : **KOOS** (knee injury and osteoarthritis outcome score)**, Goniometry** is used for measuring pre and post intervention evaluation.

Results: The Study was significant in reducing pain level and improving functional ability. At the end of six week intervention, for both group: Group A (Manual therapy with exercises) and Group B (Electrotherapy Russian current with exercises) showed improvement in the symptoms. Based on the results the study supports research hypothesis that there was a significant improvement in the ROM and functional ability or ADL performance associated with ACL injury.

Conclusion: The findings of the interventions indicate that when exercise is combined with either electrotherapy or manual therapy, both approaches lead to improvements in range of motion and functional ability. However, the results suggest that when exercise is combined with Russian current therapy, the outcomes may be slightly better compared to manual therapy combined with exercise.

INTRODUCTION

Injury to the ligament (tears and sprain) particularly the ACL are common in active individuals. Anterior cruciate ligament is an important intra-articular ligament of the knee joint because it resists anterior tibial translation and rotational stress. The anterior cruciate ligament (ACL) originates from the medial and anterior aspect of the tibial plateau and runs superiorly, laterally, and posteriorly toward its insertion on the lateral femoral condyle. The ACL consists of two major fiber bundles, namely anteromedial and posterolateral bundles[1,2].

Anterior cruciate ligament (ACL) injuries are notably frequent and severe, particularly in the context of athletic activities. These injuries typically result in joint swelling, compromised movement mechanics, muscle weakness, and diminished functional capabilities[1,3]. Furthermore, ACL injuries are often linked with long-term complications such as meniscal damage, cartilage lesions, and a heightened risk of developing early post-traumatic osteoarthritis. Notably, over 70% of ACL injuries occur without direct contact to the knee, suggesting that deficits in neuromuscular control during dynamic movements play a critical role in both initial and recurrent injuries-even after surgical reconstruction. These neuromuscular deficits contribute to excessive joint loading, which places undue stress on the ACL and can lead to its rupture. Non-contact ACL injuries typically involve multi-planar forces at the tibiofemoral joint across all three anatomical planes[4,5,6].

Management of ACL injury generally includes two main approaches: surgical treatment and non-surgical treatment. The choice of treatment depends on factors such as the severity of the injury, level of physical activity, functional instability, and the individual needs of the patient[7,8,9]. In proposed study we select the non surgical treatment of ACL injury. After reviewing many articles, research paper and recent studies that suggests the goal of treatment of ACL injury is to prevent episodes of recurrent knee instability and to protect the meniscus and articular cartilage from further trauma. This can be accomplished by nonsurgical treatment involving activity modification, lower extremity strength, and stability training and appropriate bracing. Progressive weight bearing and weight shifting can help to maintain neuromuscular activation patterns, and isolated and integrated lower extremity strengthening can be started as joint motion permits[10,11,12]. After the acute phase, rehabilitation after ACL injury can progress to recovery and functional phases. Recovery includes modalities as needed for pain, progressive strengthening, and sports-specific movement pattern progression. Functional phase activities include manual therapy, power and endurance of lower extremities, diagonal and multiplanar movements, increased neuromuscular and proprioceptive training[13,14,15]. Cryotherapy (application of ice) refered as a therapeutic intervention which helps to remove heat from the tissues and it is commonly applied in the management of acute soft tissue injuries. primary purpose of cryotherapy is to reduce pain following injuries involving muscles, tendons, or ligaments. In addition to pain relief, it is also believed to help lower tissue metabolism, minimize secondary tissue damage, control inflammation, reduce swelling, and limit the formation of hematoma after injury[16,17,18].

Manual therapy (MT) involves passive, skilled movements performed by clinicians, aimed directly or indirectly at various anatomical structures or systems, with the goal of producing positive changes in the patient's pain experience. The application of

MT is guided by clinical reasoning to optimize the management of musculoskeletal pain, addressing it from a multidimensional perspective to potentially improve clinical outcomes[14,15,19]. The effectiveness of manaul therapy may be mediated or moderated by biomechanical, neurophysiological, psychological, and nonspecific patient-related factors, offering insight into the processes and mechanisms through which manual therapy works. It includes methods such as manipulation, mobilization and massage[20,21].

Pulsed current and burst-modulated alternating current are commonly used forms of electrical stimulation in clinical rehabilitation settings[22,23]. The Burst Modulating Alternating Current include Russian current and interferential current, both of which are frequently applied to improve muscle performance and assist in rehabilitation. Among these modalities, Russian current has gained considerable attention for its role in enhancing skeletal muscle performance, particularly in healthy muscles. Its effectiveness has been supported in both research and rehabilitation practice[24]. Russian current has commonly been applied to prevent loss of muscle strength in musculoskeletal, neurological and respiratory condition. Mostly the current is applied as a part of multi model rehabilitation with co- intervention including functional training, exercises and massage[24]. Clinically, Russian current is commonly used to improve the force-generating capacity of muscles. In addition to strengthening muscles[25]

Strengthening exercise[26,27], also known as resistance or strength training, is a type of exercise designed to improve muscular strength and endurance. It involves the contraction of muscles against an external form of resistance, which may include free weights, resistance bands, machines, body weight, or even water resistance[26,28,29]. The primary aim of strength training is to enhance muscle performance and achieve outcomes such as improved joint stability, greater muscular endurance, increased muscle strength, power, and muscle mass. Regular participation in resistance training also contributes to maintaining lean muscle tissue and improving bone density, making it an important component of both rehabilitation and overall physical fitness[27,30,31].

Conservative management includes a wide variety of rehabilitative techniques and interventions aimed at improving pain, function, and joint stability. Exercise therapy is considered one of the key components of rehabilitation. Along with exercise therapy, different forms of electrotherapy and manual therapy are also commonly used in clinical practice. Therefore, in the present study, variations of electrotherapy and manual therapy have been incorporated along with rehabilitation exercises in order to evaluate their effectiveness in the management of ligament injuries. Non-surgical ACL rehabilitation is a critical area in physiotherapy, yet there is limited consensus on whether manual therapy or modalities, when combined with exercise, offer superior outcomes. While both approaches are widely used, there is a lack of comparative studies evaluating their clinical effectiveness, particularly in terms of pain relief, functional recovery, and patient satisfaction. Additionally, in resource-limited settings, understanding the cost-effectiveness and practicality of manual therapy vs. machine-based modalities is essential.

This study aims to bridge this gap by providing evidence-based insights to guide rehabilitation protocols and improve recovery in non-surgical ACL patients.

MATERIAL AND METHOD

Research Design: Comparative study
Study Setting: Patient were treated 5 times per week for 6 week at Department of physiotherapy, Pacific Medical college and hospital. UDAIPUR
Sample Design: randomized sampling
Study Population: Patient with ACL tear or injury, both male and female participants are included.
Sample Selection: 60 Patient will be randomized selected and Will be assessed for the pre-test parameter.
Study Duration: one year
Sample Size: 60 participants
Treatment Duration: single session 45-60 minutes for (5 days per week) for 6 weeks.

SELECTION CRITERIA:

Inclusion Criteria: The study would likely include patients who meet specific criteria such as:

- Informed consent/ willingness to participate in the study
- Age group 18 – 40
- Males and females with ACL tear or injury (grade I and grade II tear)
- Diagnosed with special orthopedic test (Lachman test, Anerior Drawer Sign) and MRI.

Exclusion Criteria: Certain factors exclude patients from the study, such as:

- Patient with recent fracture / stress fracture
- Any unhealed wound present at treatment site
- Age group less than 18 and more than 40
- Neurological Disorders
- Orthopedic Surgeries: History of orthopedic surgery in the last year related to KNEE.

PROCEDURE

Permission for conduct Study is taken from the institutional ethical committee of PMCH, Pacific medical university bhilo ka bedla Udaipur(RAJ).
Individuals Diagnosed with ACL (anterior cruciate ligament) tear and injury by the Physiotherapy department, Orthopedic department OPD; initially assessed for the inclusion or exclusion criteria. Prior to the treatment procedure, all participants were informed about the purpose, procedures, potential benefits, and possible risks of the study. Written informed consent was obtained from each participant prior to enrollment. Following the consent process, the participants were randomly allocated into two groups.

- 60 subjects were selected on the basis of inclusion criteria and randomly divided into Group A and Group B.
- Group A (n=30) were treated with manual therapy and exercise therapy.
- Group B (n=30) were treated with electrotherapy modalities and exercise therapy.

Group A (n=30) will be treated with manual therapy and exercise therapy.
Acute Phase (Weeks 0–2)
Cryotherapy – Ice packs 15–20 min, 2–3×/day will be applied.
Patellar Mobilization, Tibiofemoral Mobilization(Grade I–II pain relief), Soft Tissue Mobilization (Quadriceps, hamstrings, ITB), Passive Extension Stretch – Heel prop or therapist-assisted, Gentle Joint Traction – For pain modulation will be performed.

Strength & Mobility Phase (Weeks 2-4)
Cryotherapy – Ice packs 15–20 min, 2–3×/day will be applied.
Patellar Mobilization, **Tibiofemoral Mobilization** – Grade II–III to improve flexion & extension, **Joint Distraction** +

Flexion Mobilization – To gain ROM, **Soft Tissue Release** – Quads, hamstrings, calves, **PNF Stretching** – Hamstrings & quadriceps will be performed.

Advanced Phase (Weeks 4-6)

Cryotherapy – Ice packs 15–20 min, 2–3×/day will be applied.

Maintenance mobilization - Patella and tibiofemoral if stiffness persists, **High-Grade mobilization** - Grade III-IV for end-range flexion/extension (if needed), **Soft tissue mobilization/ trigger point release** - As required for muscle tightness, **PNF contrat relax stretching** - For hamstring & quadriceps flexibility will be applied suitably.

Group B (n=30) will be treated with electrotherapy modalities and exercise therapy.

Electrotherapy Modality

Cryotherapy - Ice packs 15-20 min, 2-3×/day will be applied.

Russian current - Quadriceps setting (10 sec on / 50 sec off, 10-15 min) will be administered

Common exercise protocol will be designed for rehabilitation to improve strength, gait , balance and proprioception:

Phase 1 – Acute Phase (Weeks 0–2)

Goals: Reduce pain/swelling, restore extension, initiate quad activation

- **Heel Slides** - 3×15
- **Quadriceps Sets** - 10×10 sec
- **Hamstring Isometrics** - 10×10 sec will be performed
- **Glutes activation** - 3×10 will be carried out
- **Partial Weight-Bearing with Crutches** – As tolerated will be allowed
- **Weight Shifts** - 3×10 each side **will be practiced**
- Ankle toe movement will be performed
- Sitting calf raises will be performed

Phase 2 – Strength & Neuromuscular Phase (Weeks 2-4)

Goals: Full ROM, strength gains, static balance control

- Pedocycle – 10-15 min
- Straight Leg Raises (4 planes)
- Terminal Knee Extension with Band
- Hamstring Curls (Band/Light Weight)
- Mini Squats (0–45°) Step-Ups (Low Step)
- Single-Leg Stance
- Gluteus Activation
- Hamstring Activation Sitting/Standing Calf Raise

Phase 3 – Advanced Strength & Functional Phase (Weeks 6–12)

Goals: Dynamic stability, functional strength, sport prep

- Leg Press (0–60°)
- Bulgarian Split Squats Hamstring Curls (Machine/Band**)**
- Lateral Band Walks
- Single-Leg Stance on Unstable Surface with Perturbations
- Side-to-Side Step-Overs
- Forward & Lateral Lunges

DATA ANALYSIS AND RESULTS

The findings of the study showed that manual therapy with exercise and Russian current modality combined with exercise both programmes is statistically significant improvements over a 6-week intervention period in terms of pain, gait functional ability, and overall functional performance.

However, Russian current combined with exercises consistently demonstrated greater improvements across most primary and secondary outcome measures. Particularly, the Russian current combined with exercises group showed superior reductions in all dimesmsion related to KOOS i.e. pain, symptoms, ADL Function, Sport and Recreation Function, Quality of Life.

Results are presented as Patient participated in group B shows more significant changes. Group B result were found better than group A, results as data analysis showed goniometery of group A mean±SD is 114.5±2.3 improve to 121.8±2.4 post intervention. Group B data of goniometrey pretest mean±SD is 111.9±2.2 improve to 127.4±2.5 post intervention. Data analysis of KOOS (knee injury and osteoarthritis outcome score) also significant for group B Compared to group A for group A pretest value of all component of KOOS is mean±SD is 59.6±2.1 improve to 68.9±2.3 in post test. The group B value of all component of KOOS before intervention mean±SD is 57.8±2.0 improve to 76.02±2.1 in post test. After comparing all the data it was observed that both KOOS and goniometer demonstrated significant improvement in both group. However, Russian current stimulation with exercises demonstrated greater improvements across most primary and secondary outcomes.

TABLE 1: AGE DISTRIBUTION OF PARTICIPANTS

Age Group (Years)	Group A (n)	Group A (%)	Group B (n)	Group B (%)	Total (n)	Total (%)
18–25	11	36.7%	12	40.0%	23	38.3%
26–30	7	23.3%	9	30.0%	16	26.7%
31–35	7	23.3%	4	13.3%	11	18.3%
36–40	5	16.7%	5	16.7%	10	16.7%
Total	**30**	**50%**	**30**	**50%**	**60**	**100%**

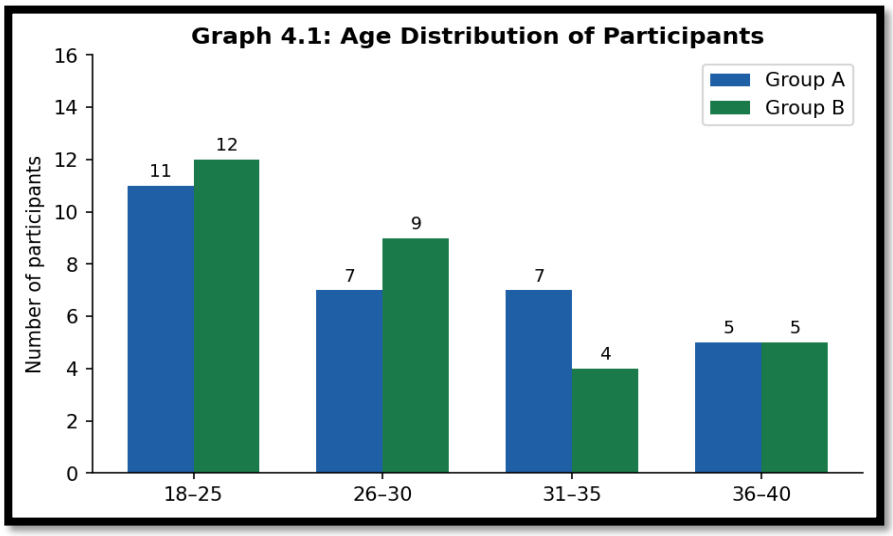

TABLE 2: GENDER DISTRIBUTION OF PARTICIPANTS

Gender	Group A (n)	Group A (%)	Group B (n)	Group B (%)	Total (n)	Total (%)
Male	23	76.7%	17	56.7%	40	66.7%
Female	7	23.3%	13	43.3%	20	33.3%
Total	30	50%	30	50%	60	100%

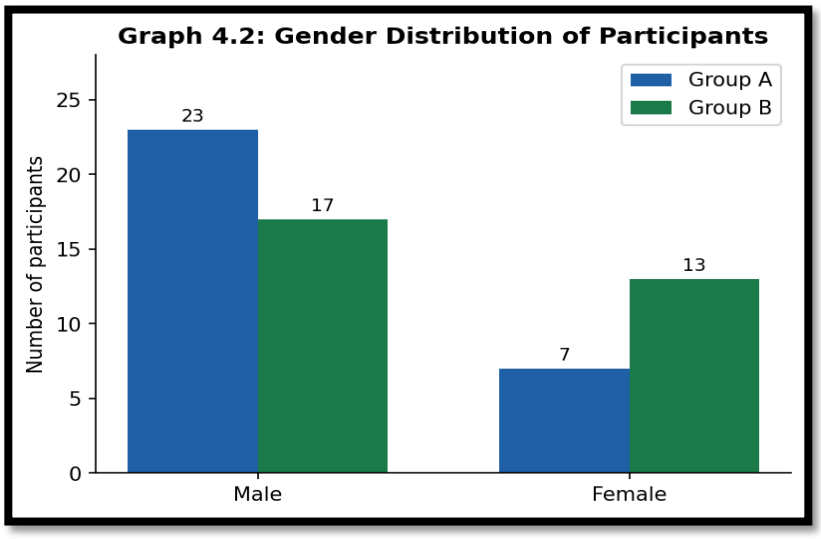

TABLE 3: BMI CATEGORY DISTRIBUTION

BMI Category	Range (kg/m²)	Group A (n=30)	Group B (n=30)
Underweight	<18.5	2 (6.7%)	3 (10.0%)
Normal	18.5–24.9	12 (40.0%)	15 (50.0%)

Overweight	25–29.9	15 (50.0%)	11 (36.7%)
Obese	≥30	1 (3.3%)	1 (3.3%)

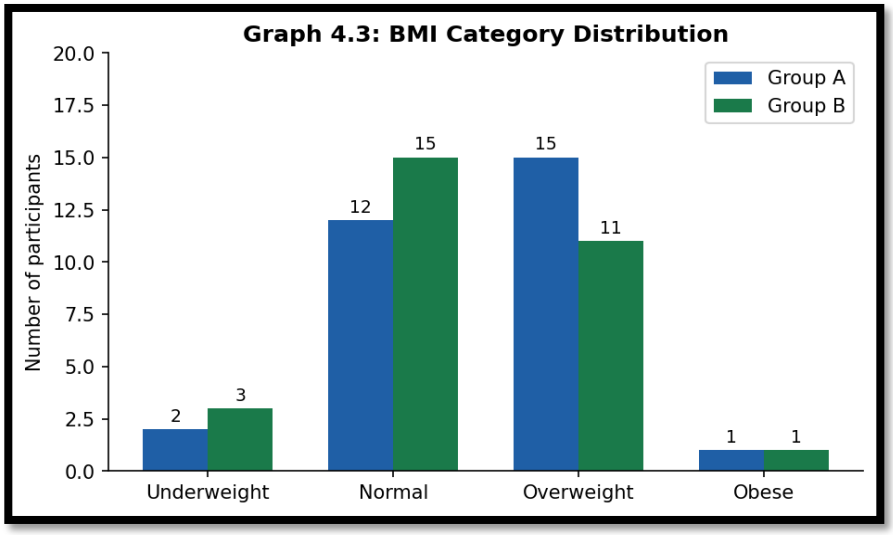

TABLE 4: AREA DISTRIBUTION

Area	Group A (n=30)	Group B (n=30)
Urban	18 (60.0%)	16 (53.3%)
Rural	12 (40.0%)	14 (46.7%)

GRAPH 4: AREA DISTRIBUTION

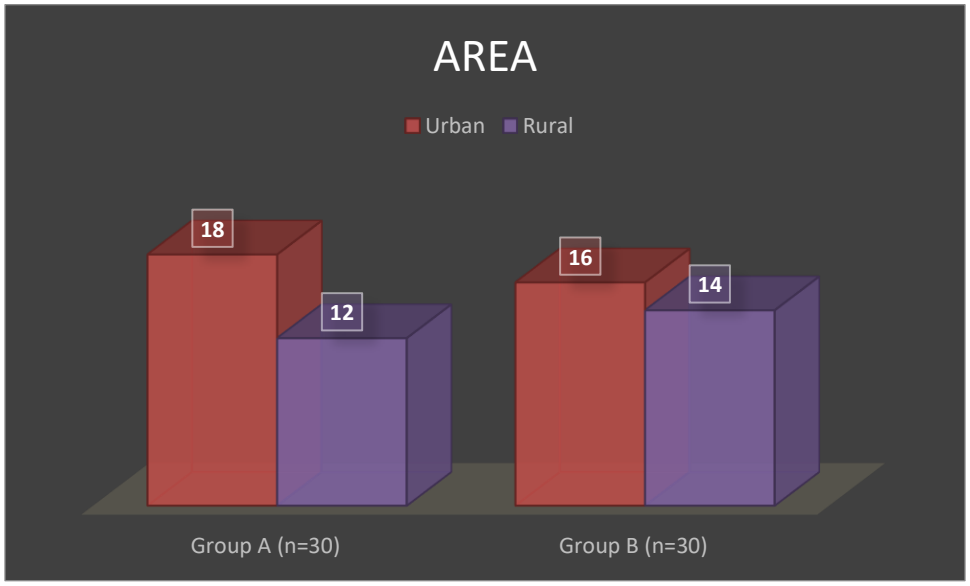

TABLE 5: GROUP A – KNEE FLEXION (GONIOMETER)

Timepoint	N	Minimum	Maximum	Mean	Std. Deviation	t-value	p-value	Result
0 Week	30	110	118	114.5	2.3	12.84	<0.001	Significant
6 Week	30	117	125	121.8	2.4			
Overall	**60**	**110**	**125**	**118.1**	**4.1**			

GRAPH 5: GROUP A – KNEE FLEXION (GONIOMETER)

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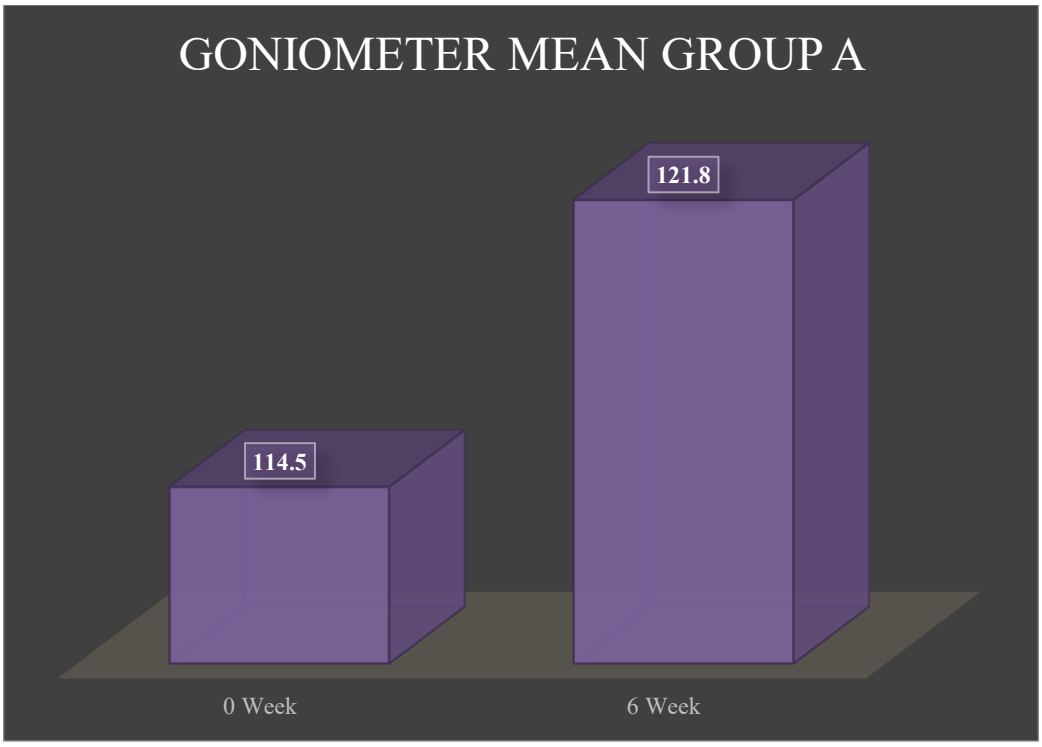


TABLE 6: GROUP A – KOOS

Timepoint	N	Minimum	Maximum	Mean	Std. Deviation	t-value	p-value	Result
0 Week	30	56	63	59.6	2.1	14.32	<0.001	Significant
6 Week	30	65	72	68.9	2.3			
Overall	60	56	72	64.2	4.8			

GRAPH 6: GROUP A – KOOS

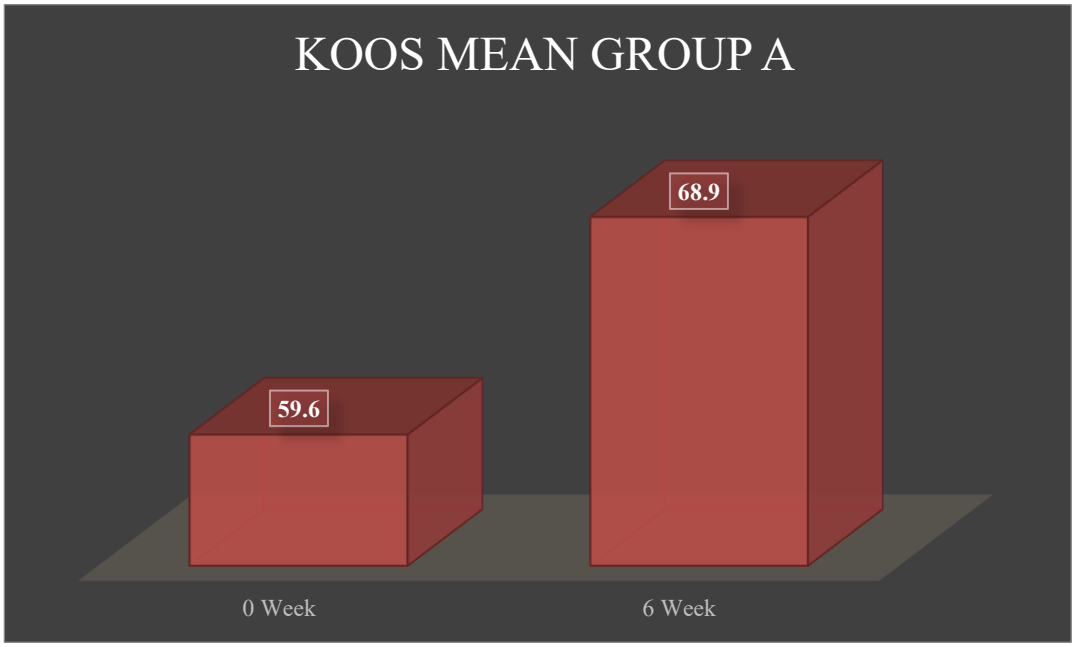


TABLE 7: GROUP B – KNEE FLEXION (GONIOMETER)

Timepoint	N	Minimum	Maximum	Mean	Std. Deviation	t-value	p-value	Result
0 Week	30	108	115	111.9	2.2	18.76	<0.001	Significant
6 Week	30	122	130	127.4	2.5			
Overall	60	108	130	119.6	7.8			

GRAPH 7: GROUP B – KNEE FLEXION (GONIOMETER)

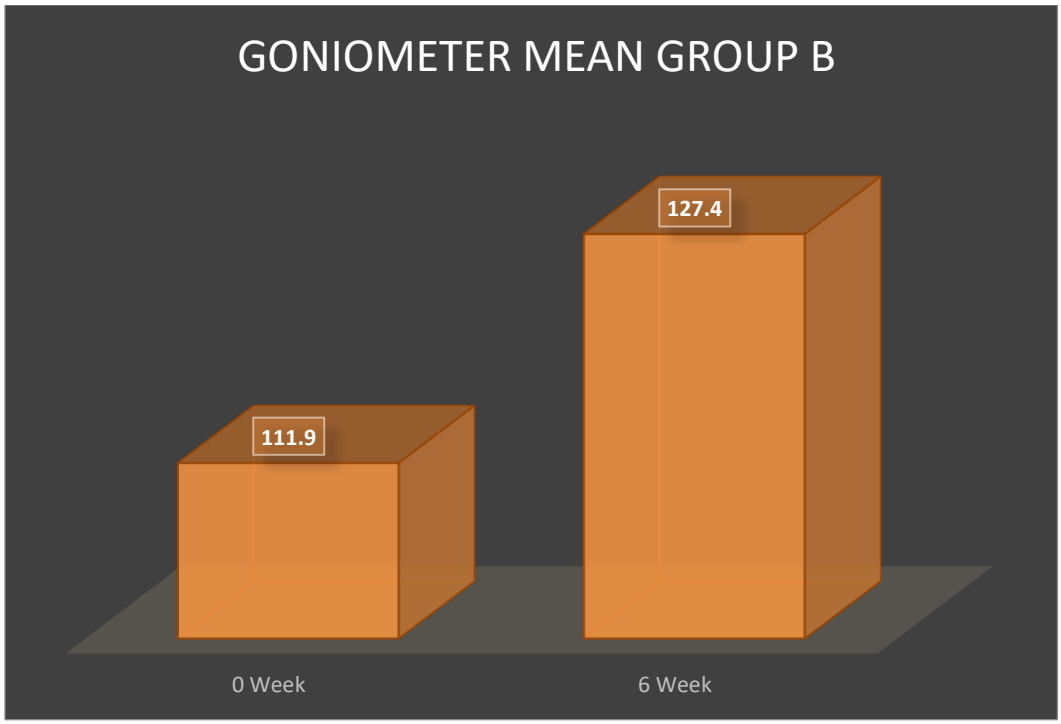
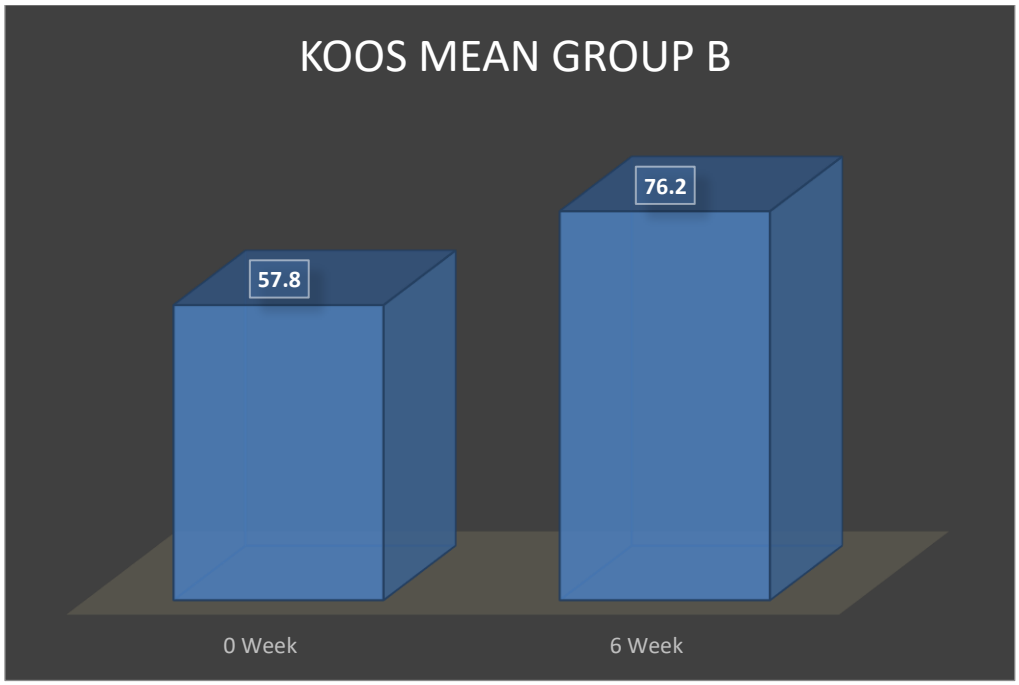


TABLE 8: GROUP B – KOOS

Timepoint	N	Minimum	Maximum	Mean	Std. Deviation	t-value	p-value	Result
0 Week	30	54	61	57.8	2.0	21.45	<0.001	Significant
6 Week	30	72	79	76.2	2.1			
Overall	60	54	79	67.0	8.9			

GRAPH 8: GROUP B – KOOS



DISCUSSION

The present comparative study was conducted to evaluate the effects of manual therapy with exercise and Russian current modality combined with exercise in the treatment of non- surgical Anterior Cruciate Ligament injury rehabilitation, with the primary aim of determining which intervention provides better functional outcomes. A total of 60 participants were included and assessed pre and post-intervention using standardized outcome measures; the goniometer and KOOS (knee injury and osteoarthritis outcome score).The findings of the study showed that manual therapy with exercise and Russian current modality combined with exercise both programmes is statistically significant improvements over a 6-week intervention period in terms of pain, gait functional ability, and overall functional performance. However, Russian current combined with exercises consistently demonstrated greater improvements across most primary and secondary outcome measures. Particularly, the Russian current combined with exercises group showed superior reductions in all dimesmsion related to KOOS i.e. pain, symptoms, ADL Function, Sport and Recreation Function, Quality of Life.

When the findings of the present study were compared with the existing literature, a moderate to strong correlation was observed between the results of the current study and those reported in previous research. The outcomes obtained from both intervention protocols, Group A (manual therapy combined with exercises) and Group B (russian current with exercises), demonstrated consistency with earlier studies, indicating that the findings of the present study are in agreement with the existing body of literature regarding the effectiveness of these rehabilitation approaches. Dai Haojie YLet.al, (2025) conducted a study to evaluate the effectiveness of exercises therapy combined with exercises in ACL injury patient to improve range of motion and findings of the suggest that combined therapy is more

effective than exercise alone. These findings are consistent with the results of the present study and further support our outcomes. An article published by Song D et.al,(2022) on the functional recovery on knee joint after ACL injury reported that intermediate frequency current stimulate the quadriceps muscle and improve knee function range of motion and decrease the pain. These findings are also support the results of our study and further support our outcome.

ACL injuries have become increasingly common not only among athletes but also within the non-athletic population due to several contributing factors such as altered lifestyle, reduced physical conditioning, poor movement mechanics, and inadequate muscular support around the knee joint. Keeping these factors in consideration, the present study was designed to evaluate the effectiveness of two different rehabilitation approaches in individuals with ACL injury. After completion of the 6-week intervention program, both groups demonstrated noticeable improvements in range of motion and functional ability. However, participants who received Russian current stimulation along with exercise therapy showed comparatively better outcomes than those treated with manual therapy. A possible reason for this difference may be related to the physiological effects of electrical stimulation. Following ACL injury, normal knee biomechanics are often disrupted, resulting in reduced neuromuscular control, quadriceps weakness, and movement asymmetry. Russian current stimulation promotes muscle contraction through medium-frequency electrical impulses, which may help improve muscle activation, enhance local circulation and metabolism, and reduce muscular inhibition. These effects may have contributed to the greater functional improvement observed in that group. Another possible explanation may be that the participants included in the study were from a non-athletic population, where physical and functional demands are generally lower than those seen in athletes. Although the intervention period was limited to 6 weeks due to factors such as time constraints, patient participation, and adherence to treatment sessions, both rehabilitation protocols produced satisfactory clinical improvements. Future studies with larger sample sizes and longer follow-up durations, preferably extending up to six months, are recommended to better understand the long-term effectiveness of these interventions.

CONCLUSION

The present comparative study was conducted to evaluate the effects of manual therapy with exercise and Russian current modality combined with exercise in the treatment of non- surgical Anterior Cruciate Ligament injury rehabilitation, with the primary aim of determining which intervention provides better functional outcomes. A total of 60 participants were included and assessed pre and post-intervention using standardized outcome measures; the goniometer and KOOS (knee injury and osteoarthritis outcome score).

The findings of the study showed that manual therapy with exercise and Russian current modality combined with exercise both programmes is statistically significant improvements over a 6-week intervention period in terms of pain, gait functional ability, and overall functional performance. However, Russian current combined with exercises consistently demonstrated greater improvements across most primary and secondary outcome measures. Particularly, the Russian current combined with exercises group showed superior reductions in all dimesmsion related to KOOS i.e. pain, symptoms, ADL Function, Sport and Recreation Function, Quality of Life.

Based on these findings, it can be concluded that while both interventions are clinically safe and beneficial, Russian current combined with exercises more effective in improving functional outcomes and activity of daily living in patients with knee pain and early osteoarthritis. Therefore, Russian current combined with exercises should be prioritized in evidence-based rehabilitation programs to facilitate optimal recovery, improve loading patterns, and support a safe and efficient quality of life while reducing the risk of injury and functional disability.

The findings and results of the present study are clinically important for physiotherapists involved in musculoskeletal and orthopedic rehabilitation, as well as for rehabilitation professionals and rehabilitation specialists. The use of Russian current combined with exercises may contribute to improving treatment strategies in the field of knee rehabilitation. The results of this study can be applied clinically to assist healthcare professionals in the better management. However, further studies with a larger sample size and more rigorous inclusion and exclusion criteria are required to validate and generalize these findings.

REFERENCE

1. Kiapour AM, Murray MM. Basic science of anterior cruciate ligament injury and repair. Bone & joint research. 2014 Feb 1;3(2):20-31.
2. Morales-Avalos R, Torres-González EM, Padilla-Medina JR, Monllau JC. ACL anatomy: Is there still something to learn?. Revista espanola de cirugia ortopedica y traumatologia. 2024 Jul 1;68(4):422-7.
3. Hauser RA, Dolan EE, Phillips HJ, Newlin AC, Moore RE, Woldin BA. Ligament injury and healing: a review of current clinical diagnostics and therapeutics. Open Rehabil J. 2013 Jan 23;6(1):1-20.
4. Kochhal N, Thakur R, Gawande V. Incidence of anterior cruciate ligament injury in a rural tertiary care hospital. Journal of family medicine and primary care. 2019 Dec 1;8(12):4032-5.
5. Dhillon MS, Rakesh J, Sharma S, Prabhakar S, Behera P, Saxena S, Singh H, Chouhan D. Epidemiology of knee injuries in Indian Kabaddi players. Asian journal of sports medicine. 2017 Mar 1;8(1).
6. Laskowski ER. ACL injury and rehabilitation. Current Physical Medicine and Rehabilitation Reports. 2014 Mar;2(1):35-40.
7. Beard DJ, Davies L, Cook JA, Stokes J, Leal J, Fletcher H, Abram S, Chegwin K, Greshon A, Jackson W, Bottomley N. Rehabilitation versus surgical reconstruction for non-acute anterior cruciate ligament injury (ACL SNNAP): a pragmatic randomised controlled trial. The Lancet. 2022 Aug 20;400(10352):605-15.
8. Davies, L., Cook, J., Leal, J., Areia, C.M., Shirkey, B., Jackson, W., Campbell, H., Fletcher, H., Carr, A., Barker, K. and Lamb, S.E., 2020. Comparison of the clinical and cost effectiveness of two management strategies (rehabilitation versus surgical reconstruction) for non-acute anterior cruciate ligament (ACL) injury: study protocol for the ACL SNNAP randomised controlled trial. *Trials*, *21*(1), p.405.
9. Beard DJ, Davies L, Cook JA, Stokes J, Leal J, Fletcher H, Abram S, Chegwin K, Greshon A, Jackson W, Bottomley N. Comparison of surgical or non-surgical management

for non-acute anterior cruciate ligament injury: the ACL SNNAP RCT. Health technology assessment (Winchester, England). 2024 Jun;28(27):1.

10. Jenkins SM, Guzman A, Gardner BB, Bryant SA, Del Sol SR, McGahan P, Chen J. Rehabilitation after anterior cruciate ligament injury: review of current literature and recommendations. Current reviews in musculoskeletal medicine. 2022 Jun;15(3):170-9.
11. Laskowski ER. ACL injury and rehabilitation. Current Physical Medicine and Rehabilitation Reports. 2014 Mar;2(1):35-40.
12. Sonesson S, Kvist J. Rehabilitation after ACL injury and reconstruction from the patients' perspective. Physical Therapy in Sport. 2022 Jan 1;53:158-65.
13. Lang PJ, Sugimoto D, Micheli LJ. Prevention, treatment, and rehabilitation of anterior cruciate ligament injuries in children. Open access journal of sports medicine. 2017 Jun 12:133-41.
14. Bhatikar K, Bhodaji S, Shanbag S. Immediate and Short Term Effect of Combination Physical Therapy and Manual Therapy in Post ACL Reconstruction Surgery Displaced Mal-Alignment of the Joint. An Invivo Clinical Trial.
15. Salamh P, Cook C, Reiman MP, Sheets C. Treatment effectiveness and fidelity of manual therapy to the knee: A systematic review and meta-analysis. Musculoskeletal care. 2017 Sep;15(3):238-48.
16. Kwiecien SY, McHugh MP. The cold truth: the role of cryotherapy in the treatment of injury and recovery from exercise. European journal of applied physiology. 2021 Aug;121(8):2125-42.
17. Frery P, Ruffault A, Esculier JF, Poignard M, Prince C, Dubois B, Edouard P. L'utilisation du froid intense par les patients en traumatologie du sport: étude par questionnaire en ligne auprès de 696 sportifs. Journal de Traumatologie du Sport. 2023 Mar 1;40(1):21-6.
18. Racinais S, Dablainville V, Rousse Y, Ihsan M, Grant ME, Schobersberger W, Budgett R, Engebretsen L. Cryotherapy for treating soft tissue injuries in sport medicine: a critical review. British journal of sports medicine. 2024 Oct 1;58(20):1215-23.
19. Bishop MD, Torres-Cueco R, Gay CW, Lluch-Girbés E, Beneciuk JM, Bialosky JE. What effect can manual therapy have on a patient's pain experience?. Pain management. 2015 Nov 1;5(6):455-64.
20. Short S, Tuttle M, Youngman D. A clinically-reasoned approach to manual therapy in sports physical therapy. International journal of sports physical therapy. 2023 Feb 1;18(1):262.
21. Espí-López GV, Arnal-Gómez A, Balasch-Bernat M, Inglés M. Effectiveness of manual therapy combined with physical therapy in treatment of patellofemoral pain syndrome: systematic review. Journal of chiropractic medicine. 2017 Jun 1;16(2):139-46.
22. Abdel-Aziem AA, Ahmed ET. Effect of Russian current stimulation on quadriceps strength of patients with burn. Int J Health Rehabil Sci. 2012;2:123-30.
23. Ward AR. Electrical stimulation using kilohertz-frequency alternating current. Physical therapy. 2009 Feb 1;89(2):181-90.

24. Fuentes J. Alternating currents: Interferential therapy, Russian stimulation and burst-modulated low-frequency stimulation. Electro Physical Agents E-Book: Evidence-Based Practice. 2020 Mar 17;85(3):340.
25. Song D, Ma Y, Zhang L, Ma Q. Intermediate frequency electrotherapy stimulation to the medial femoris muscle for functional recovery of knee joint after anterior cruciate ligament reconstruction. Pakistan journal of medical sciences. 2022 Mar;38(3Part-I):652.
26. Stojanović MD, Andrić N, Mikić M, Vukosav N, Vukosav B, Zolog-Șchiopea DN, Tăbăcar M, Melinte RM. Effects of eccentric-oriented strength training on return to sport criteria in late-stage anterior cruciate ligament (ACL)-reconstructed professional team sport players. Medicina. 2023 Jun 8;59(6):1111.
27. Panton LB, Artese AL. Types of exercise: Flexibility, strengthening, endurance, balance. InExercise for Aging Adults: A Guide for Practitioners 2024 Apr 24 (pp. 47-69). Cham: Springer International Publishing.
28. Zatsiorsky VM, Kraemer WJ, Fry AC. Science and practice of strength training. Human kinetics; 2020 Mar 25.
29. Bullo V, Favro F, Pavan D, Bortoletto A, Gobbo S, De Palma G, Mattioli S, Sala E, Cugusi L, Di Blasio A, Diaz DC. The role of physical exercise in the prevention of musculoskeletal disorders in manual workers: a systematic review and meta-analysis. La Medicina del lavoro. 2024 Feb 22;115(1):e2024008.
30. Suchomel TJ, Nimphius S, Bellon CR, Stone MH. The importance of muscular strength: training considerations. Sports medicine. 2018 Apr;48(4):765-85.
31. Shabbir M, Umar B, Ehsan S, Munir S, Bunin U, Sarfraz K. Comparison of functional training and strength training in improving knee extension lag after first four weeks of total knee replacement. Biomed Res. 2017 Jan 1;28(12):5623-7.
32. Grindem H, Eitzen I, Engebretsen L, Snyder-Mackler L, Risberg MA. Nonsurgical or surgical treatment of ACL injuries: knee function, sports participation, and knee reinjury: the Delaware-Oslo ACL Cohort Study. JBJS. 2014 Aug 6;96(15):1233-41.
33. Moksnes H, Snyder-Mackler L, Risberg MA. Individuals with an anterior cruciate ligament-deficient knee classified as noncopers may be candidates for nonsurgical rehabilitation. journal of orthopaedic & sports physical therapy. 2008 Oct;38(10):586-95.
34. Collins NJ, Prinsen CA, Christensen R, Bartels EM, Terwee CB, Roos EM. Knee Injury and Osteoarthritis Outcome Score (KOOS): systematic review and meta-analysis of measurement properties. Osteoarthritis and cartilage. 2016 Aug 1;24(8):1317-29.
35. Kolber MJ, Hanney WJ. The reliability and concurrent validity of shoulder mobility measurements using a digital inclinometer and goniometer: a technical report. Int J Sports Phys Ther. 2012 Jun;7(3):306-13. PMID: 22666645; PMCID: PMC3362980.