

## The Role of Eccentric Training and Pain Neuroscience Education (PNE) to Improve Quadriceps Muscle Strength, and Function in Post ACL Repair: A Case Report

Dhiraj Tatiya <sup>1</sup>, Tajuddin Chitapure <sup>1,2\*</sup>, Amreen Shaikh <sup>3</sup>, Ankita Jaju <sup>4</sup>

<sup>1</sup>B.P.T Intern, MGM School of Physical therapy, Aurangabad, a constituent unit of MGMIHS, Navi Mumbai, Maharashtra, India

<sup>2</sup>Assistant Professor, Musculoskeletal department, MGM School of Physical therapy, Aurangabad, a constituent unit of MGMIHS, Navi Mumbai, Maharashtra, India

<sup>3</sup>M.P.T student, Musculoskeletal department, MGM School of Physical therapy, Aurangabad, a constituent unit of MGMIHS, Navi Mumbai, Maharashtra, India

<sup>4</sup>B.P.T Intern, MGM School of Physical therapy, Aurangabad, a constituent unit of MGMIHS, Navi Mumbai, Maharashtra, India

**Corresponding Author:** Tajuddin Chitapure, E-mail: taj.chitapure@mgsop.edu.in

### ARTICLE INFO

#### Article history

Received: April 15, 2021

Accepted: July 02, 2021

Published: July 31, 2021

Volume: 9 Issue: 3

Conflicts of interest: None

Funding: None

### ABSTRACT

**Background:** A 19-year-old man presented with right knee pain while bearing weight on the right leg and difficulty bending the right knee. He was diagnosed with a complete -tear of the anterior cruciate ligament. After ACL reconstruction this individual was referred to physical therapy treatment. **Objective:** To investigate if neuroscience pain education, and eccentric training, have any therapeutic significance in post-ACL reconstructive patients. **Method:** After assessment, the first day of the first week, introduced a treatment protocol consisting of basic range of motion (ROM) and isometric exercises for three sets of 10–30 sec hold. From first to fourth week eccentric exercises along with pain neuroscience education (PNE) sessions were given on alternate days, with three sessions for PNE and eccentric exercises until fourth week. **Result:** As shown in this study, treatment with a combination of PNE and eccentric training results in improved quadriceps muscle strength, range of motion, and overall function. **Conclusion:** This report suggested that PNE in conjunction with eccentric exercise has clinical merit. Clinical implication of study is examining the effectiveness of this approach should be conducted in the form of well-designed, clinical studies.

**Keywords:** Pain, Anterior Cruciate Ligament Injuries, Quadriceps Muscle, Exercise Therapy.

### INTRODUCTION

The ACL is the most commonly injured ligament in the knee joint (Evans & Nielson, 2020). As a health education technique, educating pain neurosciences (PEN) can modify misconceptions and reduce pain catastrophe, kinesiophobia and attitude of fear-avoidance. It has been shown that when PNE therapies are paired with a physical exercise directed program, in chronic pain, the results are improved (Galan-Martin et al., 2020). Pain neuroscience education (PNE) is a form of cognitive therapy that teaches patients about their pain from a biological and physiological perspective (Louw et al., 2016).

Interventions to safely overload quadriceps muscles following repair of the anterior cruciate (ACL) ligament are necessary to minimise the muscular weakness of the quadriceps that often persists long after recovery. Despite the fact that strength training uses the identical external stresses during the concentric and eccentric stages of the exercise, research shows that eccentric overload workouts optimise muscle growth and strengthening (Lepley & Palmieri-Smith, 2013).

Eccentric training has been shown in studies with healthy elderly, young people, and athletes to increase muscle mass, strength, and functional performance more than standard strength training. Similarly, eccentric training appears more effective in restoring quadriceps muscle mass, strength and functional performance in patients undergoing ACL repair this observation supports the use of eccentric training in rehabilitation programme for these patients' safety and efficacy (Vidmar et al., 2020)

Following anterior cruciate ligament (ACL) surgery, interventions targeted at safely stressing the quadriceps muscle are important for decreasing quadriceps muscular weakness, which typically remains long after the recovery phase (Lepley & Palmieri-Smith, 2013). In patients after an ACL repair, eccentric exercise appears more beneficial in restoring quadriceps muscle size, strength, and functional performance (Vidmar et al., 2020). Therefore, in this study we hypothesize the use of PNE in combination with eccentric training program to investigate its effectiveness for the recovery of

quadriceps muscle size, strength, and function after reconstruction of complete ACL tear.

**CASE**

**Patient Description**

A 19-year-old student presented to the physical therapy with a right knee pain and a difficulty in bending. The cause was a fall suffered six month ago while playing cricket. The injury occurred when landing from jumping on the field. After few months, his knee pain gradually increased day by day with the inability to bend his right knee. Imaging (Magnetic resonance imaging) revealed a complete ACL tear. After reconstructive surgery he was referred to physical therapy.

**Physical Examination**

The pain was gradual in onset since six month and intermittent in nature and quality dull aching pain. (Visual analog scale is scored from 0-10) (Arumugam et al., 2017) Pain was 7 on visual analog scale while walking. On palpation, Grade 1 tenderness was reported in the anterior aspect of the knee. During evaluation, active range of motion (ROM) of the right knee before and post-treatment is shown in Table 1.1, with table 1.2 referring to manual muscle testing before and post-treatment according to the Medical Research Council (MRC) grading system. During examination swelling was present in the right knee with it being in a slightly flexed posture (Carlson, 2020).

**Investigations and Diagnosis**

Based on objective and subjective examinations, an MRI report, and a previous investigation of the affected leg, a complete ACL tear had occurred.

**Interventions**

After collecting the information from the patient about his knowledge and perspective for his pain and current condition and informed consent, a treatment protocol was developed using both PNE and eccentric exercises. On the first day of week one, the patient was educated about their current condition, and the treatment protocol developed to address the strengthening of the right quadriceps muscle, knee ROM and the reduction in swelling. The ROM exercises consisted of three sets of 10 repetitions and with knee isometric exercises consisting of three sets of 10-30 sec holds.

From the second day until the end of first week, the patient received PNE on alternate days for a total of three sessions. In the first during the second session, the patient was educated on the use of PNE for pain referring to its biomechanical relationship and pathomechanical malalignments, with the third session dedicated to explaining the relationship of PNE to chronic pain sensitization, hyperalgesia, allodynia, and brain plasticity are being studied in order to get a better understanding of chronic pain and its role in therapy (Larsen et al., 2020) (Daneshjoo et al., 2020). In addition to PNE offered in the first week, eccentric loading exercise were introduced and continued till the fourth week. When the patient was on the ergo metre, negative work was performed on the patient from almost 20° to 60° of knee flexion, minimising the likelihood of a knee hyperextension injury. The intensity of the workout was determined using the Borg Rate of Perceived Exertion (RPE) scale (Gerber et al., 2007). Beginning 3-week post-surgeries, the patient began a negative work exercise program using an ergo meter. With speed of pedal was ranged from 20 to 40 rpm. The first session lasted 5 min in duration at low intensity. Subjects were permitted to gradually proceed to a “hard” intensity and a maximum length of 30 min, assuming a good individual reaction to exercise.” (Gerber et al., 2006). After six week patients were given information pamphlets summarizing the PNE contents

**Table 1. 1.** Goniometry measurements for the right knee active and passive pre- and post-treatment, on the day 1 of week 1 and last day of week 6

Right Knee	Active ROM (Day 1, week 1)	Active ROM (Last day, week 6) on 6 <sup>th</sup> week)	Passive ROM (Day 1, week 1) first day on 1 <sup>st</sup> week)	Passive ROM (Last day, week 6)
Flexion	0–80 degrees	0–115 degree	0–85 degrees	0–120 degree
Extension	80-0degree	115–0 degree	85–0 degree	120–0 degree

**Table 1. 2.** MRC right knee pre- and post-treatment on day 1 and last day of week 6

Muscles (MRC)	Pre-treatment strength on day 1.	Post-treatment strength on the last day week 6.	Pre-treatment strength on day 1.	Post-treatment strength on the last day week 6
	Right Knee	Right Knee	Left Knee	Left Knee
Hamstring	3	5	4	4
Quadriceps	3	4	4	4
Iliopsoas	3	4	4	4
Gluteus maximums	4	4	4	4
Gluteus medius	4	4	4	4

following the PNE sessions. As per international standard or university standard, patients' written and informed consent has been collected and preserved by the author(s).

### Follow-up and Outcomes

On day one the sensation of pain on the VAS scale was seven, decreasing to two after six weeks of the PNE-eccentric treatment protocol. Similarly, it was observed that after six weeks, quadriceps strength and knee ROM increased (Table 1.1 & 1.2). Outcome measures consisted of a VAS for Pain, ROM (Universal Goniometry) and muscle strength (Medical Research Council MRC) grading.

### DISCUSSION

According to this case study, the combination of PNE and eccentric exercise was observed to be very beneficial and effective in improving quadriceps muscle strength, knee ROM, and overall function. Pain neuroscience education has been used as a treatment for chronic pain patients, applying contemporary neuroscience knowledge enabling individuals to rethink their pain experiences. In this case, pain neuroscience education in that patient focuses mostly about what pain is involved in the neurophysiology of pain biopsychological model, the understanding of pain perceptions, or positive outlook on life, and we have shown that PNE may minimize kinesio-phobia, pain depression, and pain attitudes about pain management, physical damage, and medications, and psychosocial features.

Knee injuries are one of the most frequent forms of injuries encountered in practice, with 33% of individuals reporting a past knee injury. Miguel Angel Galan-Martin et al. in 2020 showed that PNE in combination with a and physical exercise (PE) program for chronic spinal pain patients was more efficient than traditional treatment in all examined variables, both at the termination of the treatment and at the six month follow-up (Galan-Martin et al., 2020). In the current case report, the patient responded positively to the use of PNE therapy. This therapy enabled the patient to alter their attitudes regarding dysfunction assisting them in comprehending the pathomechanics of pain and movement. Another research investigates the influence of Pain Neuroscience Education (PNE) on students studying Sports Therapy and Rehabilitation (STR). A single 70-minute PNE session improved Understanding pain neurobiology and attitudes toward athletes with chronic pain among STR students, according to the findings (Maguire et al., 2019).

In earlier work, isokinetic eccentric exercise enhanced muscular mass of quadriceps and strength more than conventional eccentric training in recreational athletes undergoing ACL reconstruction (Lepley et al., 2015). They observed that an eccentric after ACL repair exercise was found to increase activation and strength of the quadriceps favorably. In this study we combined PNE with the eccentric program to evaluate whether there was any further improvement and prevention of recurrence, as well as to assist the patient in returning to work earlier than expected. Eccentric exercise has a favourable effect on the quadriceps muscle and its function

after ACL repair. Eccentric training is already proved in ACL reconstructive patients. So overall if we use PNE along with eccentric training it shows significant improvement in ACL reconstructive patients.

### Limitation and Recommendation

The patient reported functional outcome was not included in this current case report, which may be a limitation. However, this protocol can be employed for a larger study to gain better knowledge of the relationship between PNE and eccentric exercise in ACL injuries. To evaluate the success of this approach, further research should be carried out in the form of well-designed clinical studies. While the research cannot show a link between cause, effect, it does allow the first formulation of hypotheses that PNE along with an expert strategy may have a therapeutic value.

### Strength and Practical Implication of Study

This demonstrates that PNE can be used as part of post-ACL rehabilitation to improve overall treatment outcomes, prevent recurrence of ACL injuries, and promote early return to work or play. As a result of PNE, patients have a better understanding of pain physiology and can link it to movements. PNE has already been used to treat a variety of chronic musculoskeletal pain conditions with positive results. The pain biopsychological model focuses on pain neuroscience education, the comprehension of pain experiences, or a positive outlook on life.

### CONCLUSION

After 6-week of eccentric training program with PNE may be more effective in post-ACL reconstruction for quadriceps muscle recovery, improving strength, and the size of muscle, also the increase in knee ROM. So to post-ACL reconstructive patients, PNE has an additive effect with eccentric training. The patient expressed his satisfaction with the positive results that in comparison with day one and overall functional enhancement.

### REFERENCES

- Arumugam, H. H., Balaraman, T., Bains, B. S., & Sadeghi, H. (2017). The Prevalence Of Upper Limb Pain Among Veena Players: A Cross-Sectional Survey. *Revista Pesquisa Em Fisioterapia*, 7(3), 326–331. <https://doi.org/10.17267/2238-2704rpf.v7i3.1423>
- Carlson, K. (2020). Assessment of Post-Rehabilitation ACL Reconstructed Knees. *International Journal of Kinesiology and Sports Science*, 8(2), 33–39. <https://doi.org/10.7575/aiac.ijkss.v.8n.2p.33>
- Daneshjoo, A., Tavakol, A., & Sadeghi, H. (2020). Effect of Twelve Sessions of Tai Chi Exercise on Static and Dynamic Balance in Young Girls. *International Journal of Kinesiology and Sports Science*, 8(1), 26–30. <https://doi.org/10.7575/aiac.ijkss.v.8n.1p.26>
- Evans, J., & Nielson, J. I. (2020). *Anterior Cruciate Lig-*

- ament Knee Injurie. <https://www.ncbi.nlm.nih.gov/books/NBK499848>
- Galan-Martin, M. A., Montero-Cuadrado, F., Lluch-Girbes, E., Coca-López, M. C., Mayo-Iscar, A., & Cuesta-Vargas, A. (2020). Pain Neuroscience Education and Physical Therapeutic Exercise for Patients with Chronic Spinal Pain in Spanish Physiotherapy Primary Care: A Pragmatic Randomized Controlled Trial. *Journal of Clinical Medicine*, 9(4), 1201. <https://doi.org/10.3390/jcm9041201>
- Gerber, J. P., Marcus, R. L., Dibble, L. E., Greis, P. E., Burks, R. T., & Lastayo, P. C. (2007). Safety, Feasibility, and Efficacy of Negative Work Exercise Via Eccentric Muscle Activity Following Anterior Cruciate Ligament Reconstruction. *Journal of Orthopaedic & Sports Physical Therapy*, 37(1), 10–18. <https://doi.org/10.2519/jospt.2007.2362>
- Gerber, J. P., Marcus, R. L., Dibble, L. E., Greis, P. E., & LaStayo, P. C. (2006). Early Application of Negative Work via Eccentric Ergometry Following Anterior Cruciate Ligament Reconstruction: A Case Report. *Journal of Orthopaedic & Sports Physical Therapy*, 36(5), 298–307. <https://doi.org/10.2519/jospt.2006.2197>
- Larsen, J. B., Skou, S. T., Arendt-Nielsen, L., Simonsen, O., & Madeleine, P. (2020). Neuromuscular exercise and pain neuroscience education compared with pain neuroscience education alone in patients with chronic pain after primary total knee arthroplasty: Study protocol for the NEPNEP randomized controlled trial. *Trials*, 21(1), 218. <https://doi.org/10.1186/s13063-020-4126-5>
- Lepley, L. K., & Palmieri-Smith, R. M. (2013). Effect of Eccentric Strengthening After Anterior Cruciate Ligament Reconstruction on Quadriceps Strength. *Journal of Sport Rehabilitation*, 22(2), 150–156. <https://doi.org/10.1123/jsr.22.2.150>
- Lepley, L. K., Wojtys, E. M., & Palmieri-Smith, R. M. (2015). Combination of eccentric exercise and neuromuscular electrical stimulation to improve quadriceps function post-ACL reconstruction. *The Knee*, 22(3), 270–277. <https://doi.org/10.1016/j.knee.2014.11.013>
- Louw, A., Puentedura, E. J., Zimney, K., & Schmidt, S. (2016). Know Pain, Know Gain? A Perspective on Pain Neuroscience Education in Physical Therapy. *Journal of Orthopaedic & Sports Physical Therapy*, 46(3), 131–134. <https://doi.org/10.2519/jospt.2016.0602>
- Maguire, N., Chesterton, P., & Ryan, C. (2019). The Effect of Pain Neuroscience Education on Sports Therapy and Rehabilitation Students' Knowledge, Attitudes, and Clinical Recommendations Toward Athletes With Chronic Pain. *Journal of Sport Rehabilitation*, 28(5), 438–443. <https://doi.org/10.1123/jsr.2017-0212>
- Vidmar, M. F., Baroni, B. M., Michelin, A. F., Mezzomo, M., Lugokenski, R., Pimentel, G. L., & Silva, M. F. (2020). Isokinetic eccentric training is more effective than constant load eccentric training for quadriceps rehabilitation following anterior cruciate ligament reconstruction: A randomized controlled trial. *Brazilian Journal of Physical Therapy*, 24(5), 424–432. <https://doi.org/10.1016/j.bjpt.2019.07.003>