

Effect of PNF Exercise Versus Core Strengthening Exercise on Proprioception, Balance, and Range of Motion of Ankle Joint in Younger Adults with Chronic Ankle Instability - A Comparative Study

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ABSTRACT

Chronic ankle instability is a common issue among young adults, it often results in repeated ankle sprains, reduced proprioception, impaired balance, and limited range of motion. This study represents the comparison between the impacts of PNF exercises and core strengthening exercises on proprioception, balance, and range of motion in individuals between the age group 1-24 with chronic ankle instability. 23 participants were randomly assigned to either a PNF or core strengthening, each following an 8-week structured exercise protocol. Cumberland Ankle Instability Tool and ankle goniometry were used to assess participant's ankle instability before and after the given intervention. Both groups represented meaningful improvements, but those in core strengthening group showed greater improvements in joint sense, balance, range of motion, and self-reported ankle function, representing statistically significant results. These results represents that core strengthening exercises offers broader benefits for functional ankle improvement in young adults with chronic ankle instability. The study also encourages that

core strengthening exercises may promote neuromuscular co-ordination and dynamic control. As recent research shows no single technique is universally superior the protocol should design to meet patient's needs. Future research should include longer-term follow-up and consider additional lifestyle. This direction may further enhance ankle stability and quality of life for those with chronic ankle instability.

Keywords: PNF exercise, Core strengthening exercise, Chronic Ankle Instability, proprioception, balance, range of motion, young adults, Cumberland Ankle Instability tool, Ankle Goniometry.

INTRODUCTION

Chronic ankle instability is a progressive condition marked by recurrent ankle sprains causing pain, swelling, reduced range of motion, weakness and a continuous feeling of ankle "giving way". It is most common in young adults with prevalence of approximately 25%, and 46% for those who have previous history of untreated ankle sprains. Recurrent ankle sprains increase the risk of repetitive injury and lead to negative effects in muscle strength, joint movement,

proprioception, balance and overall functional performance. If not treated within an appropriate recovery window it may result in permanent ankle changes and reduced ability to perform ADLs.

It affects both local and systemic function, with possible contribution to early micro traumatic degeneration and increasing load on ligaments. Sensorimotor deficiency including reduced afferent input, reflex responses and motor control are prevalent including both feedback and feed-forward mechanism. These circumstances may arise from ligamentous damage, leading to mechanical instability whereas functional instability is due to proprioceptive and muscular deficits, both commonly coexist.

Effective rehabilitation is necessary to encourage strength, proprioception, range, balance, and load bearing capacity of ankle joint. PNF exercises can enhance proprioception and help in detection of false positioning while core strengthening improves postural control and reduces compensatory ankle movements.

Assessment tools include the Cumberland Ankle Instability Tool which shows strong validity ($\alpha=0.3$), high test-retest reliability (ICC+0.96) and a threshold score of 27.5 (sensitivity 82.9, specificity 74.7). Evaluating activity level is also essential to determine risk, and compare functional outcomes. Chronic Ankle Instability is prevalent in young adults and is linked with prominent negative effects and high risk of progression to permanent ankle changes. Although various exercise protocol is traditionally used for management, limited research has evaluated their functional efficacy across diverse population, PNF incorporates both strengthening and stretching effects to improve dynamic joint stabilisation, while core strengthening on the other hand plays important role in maintain equilibrium during dynamic movements, encouraging equal ankle loading and improved balance.

The aim of this study is to compare the effectiveness of PNF versus core

strengthening exercises on proprioception, balance, and range of motion in young adults with chronic ankle instability

Objective of the study is to assess the effectiveness of PNF exercise on proprioception, balance, and range of motion, to assess the effectiveness of core strengthening exercise on proprioception, balance and range of motion, and to compare the effect of both PNF and core strengthening exercise

LITERATURE REVIEW

- 1) Gribble, P. A., Delahunt, E., Bleakley, C., Fourchet, F., et al. (2013). Decided selection criteria for patients with chronic ankle instability in controlled research: a position statement of the international ankle consortium. The number of previous ankle sprains, the presence of and frequency of reported episodes of “giving way”. The presence of and frequency of reported episodes of feelings of instability. The scores on the validated self-reported ankle instability instruments utilized to establish inclusion criteria, etc.
- 2) Hertel J. (sports medicine 2000) functional instability following lateral ankle sprains suggested when LAS occurs structural damage not only occurs to the ligament tissues but also to the nervous and musculotendinous tissue around ankle complex. While neuromuscular deficits are also likely to occur due to injury to the nervous tissue. Assessment and rehabilitation of patients with LAS must address not only joint laxity and swelling but also include examination and restoration of neuromuscular tissue and neuromuscular function respectively.
- 3) Doherty C, Delahunt E, Caufield B, Hertel J Ryan J, Bleakley C, (sports medicine 2014) presented the incidence and prevalence of ankle sprains injury: a systemic review and meta-analysis of prospective epidemiological studies, suggested that participants were at

significantly higher risk of sustaining a lateral ankle sprain compared with syndesmotic and medial ankle sprain.

- 4) McKeon PO, Hubbard TJ, Wikstrom EA. Presented consequences of ankle inversion trauma. Hypothetical cascade of events that causes development of CAI: acute sprains damage ligament integrity and afferent accuracy, the initial damage then leads to joint malalignment and spinal reflex inhibition, joint loads and central organisation of movement are then altered over time developing post traumatic OA.
- 5) Zouita ABM, Majdoub O, Grandy K, Dziri C, Salah FB. Presented the effect of 8 weeks proprioceptive exercise program in chronic ankle instability of Tunisian athletes. Right after 8 weeks of proprioceptive work significant increase of maximal strength, decrease in times of 18 acceleration, and deceleration at the level of plantar flexors and better

stability of injured limb. Proprioceptive training exercises can effectively an unstable ankle above for muscular and postural control.

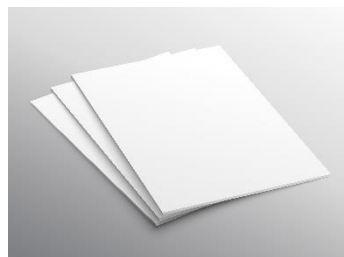
- 6) Somayeh Alizamani, Gholmali Ghasemi, Shahram lenjan Nejadian (1Apr 2023) presented background chronic ankle instability is a common injury among athletes. Research has reported reduced dorsiflexion range of motion, impairment of proprioception, reduced muscle strength of ankle in individuals with CAI. After examination of 8 weeks of core stability training on stable and unstable surfaces on ankle muscular strength, proprioception and dorsiflexion ROM in athletes with CAI. Which showed positive effect hence this type of training is recommended as a therapeutic option for individuals with CAI.

MATERIALS & METHODS

GONIOMETER



PAPER



PEN



CUMBERLAND ANKLE INSTABILITY TOOL

orthotoolkit

Cumberland Ankle Instability Tool (CAIT) Summary
This survey addresses the right ankle

1. I have pain in my ankle Never	(3 points)
2. My ankle feels UNSTABLE Never	(4 points)
3. When I make SHARP turns, my ankle feels UNSTABLE Never	(3 points)
4. When going down the stairs, my ankle feels UNSTABLE Never	(3 points)
5. My ankle feels UNSTABLE when standing on ONE leg Never	(2 points)
6. My ankle feels UNSTABLE when Never	(3 points)
7. My ankle feels UNSTABLE when Never	(4 points)
8. TYPICALLY, when I start to roll over (or twist) on my ankle, I can stop it Immediately	(3 points)
9. After a TYPICAL incident of my ankle rolling over, my ankle return to "normal" Almost immediately	(3 points)

Pertinent Negative Pertinent Positive Pertinent Positive

Cumberland Ankle Instability Tool Score:
30/30=100 percent.

Graphical Cumberland Ankle Instability Tool Score:

PNF Exercise protocol

Sr. no	Exercise (pattern)	Starting position	Movement description	Target muscles	Dosage	Frequency
1	D1 flexion	Seated/supine	From PF + Eversion – DF + Inversion	Tibialis anterior, extensor dig longus, peroneals	3 sets× 10-15 reps	Daily
2	D1 extension	Seated/supine	DF + Inversion – PF + Eversion	Gastrocnemius, soleus, peroneals	3 sets× 10-15 reps	Daily
3	D2 flexion	Seated/supine	PF + inversion – DF + eversion	Tibialis anterior, peroneus longus, extensor hallucis longus	3 sets× 10-15 reps	Daily
2	D2 extension	Seated/supine	PF + inversion - DF inversion	Gastrocnemius, soleus, Tibialis anterior	3 sets× 10-15 reps	Daily

Progression:

Sr. no	Exercise (pattern)	Resistance application	Movement description	Target muscles	Dosage	Frequency
1	D1 flexion	Towel loop around ball of foot, pressed with opposite foot	From PF + Eversion – DF + Inversion	Tibialis anterior, extensor dig longus, peroneals	3 sets× 10-15 reps	Daily
2	D1 extension	Towel loop around ball of foot, pressed with opposite foot	DF + Inversion – PF + Eversion	Gastrocnemius, soleus, peroneals	3 sets× 10-15 reps	Daily
3	D2 flexion	Towel loop around ball of foot, pressed with opposite foot	PF + inversion – DF + eversion	Tibialis anterior, peroneus longus, extensor hallucis longus	3 sets× 10-15 reps	Daily
2	D2 extension	Towel loop around ball of foot, pressed with opposite foot	PF + inversion - DF inversion	Gastrocnemius, soleus, Tibialis anterior	3 sets× 10-15 reps	Daily

Core strengthening protocol

Sr. no	Exercise (pattern)	Starting position	Movement description	Dosage	Frequency
1	Front plank	Forearms on ground, body neutral on toes	Hold static plank for 20-30 sec	3 sets× 2 -3 reps	Daily
2	Bird dog	Quadruped (hands under shoulder, knees under hips)	Lift opposite arm and leg, hold 2-3 sec	3 sets× 10-12 reps/side	Daily
3	Glute bridge	Supine, knees bent, feet flat	Lift pelvis, hold 3-5 sec	3 sets× 10-15 reps	Daily
4	Standing march with core activation	Standing, hip-width stance, support as needed	Lift knee to hip height maintains trunk stability	3 sets× 10-15 reps/leg	Daily

Progression:

Sr. no	Exercise (pattern)	Starting position	Movement description	Dosage	Frequency
1	Plank with leg lift	Forearm plank	Lift one leg at time holds 2-3sec	3 sets× 8 -10 reps/leg	Daily
2	Russian twists	Seated, knees	Lean back slightly, rotate	3 sets× 10	Daily

	(no weights)	bent, heels on floor	trunk side to side	reps/side	
3	Mountain climbers	High plank (on hands)	Alternate knees toward chest dynamically	3 sets× 30 sec	Daily

Statistical Analysis

Pre –post analysis for group A:

Outcome measure	Pre mean	SD	Post-mean	SD	P-value
CAIT	16.2	3.7	22.3	2.8	<0.001
ROM	15.8	3.6	22.5	3.2	<0.001

Pre-post analysis for group B:

Outcome measure	Pre-mean	SD	Post-mean	SD	p-value
CAIT	12.5	3.15	19.1	4.2	<0.003
ROM	12.3	3.1	20.7	4.0	<0.004

Between group analysis for group A and B:

Outcome measure	Post-mean group A	Post-mean group B	P value	ain	ain
CAIT	22.3	19.1	0.02	Ain	nn
ROM	22.5	20.7	0.09	ain	ain

RESULT

The following study was done to compare the effect of PNF exercise and core strengthening exercise on balance, proprioception, and range of motion of the ankle joint in young adults with chronic ankle instability.

The values of all the outcome measures pre-intervention and post-intervention were analysed using IBM SPSS software.

The post mean value for core strengthening exercises with respect to Cumberland Ankle Instability Tool is 22.3, and Range of motion is 22.5, while the values for PNF exercises with respect to Cumberland Ankle Instability Tool is 19.1 and range of motion is 20.7

The test used for statistical analysis are: Paired T test and Unpaired T test

The p-value ≤ 0.05 was considered to statistically significant

The statistical analysis shows that the effect of core strengthening exercise is more significant.

DISCUSSION

Chronic ankle instability is highly common injury among young adults and is marked by recurrent ankle sprains, persistent pain and a sensation of instability. Two commonly used exercise protocols are PNF exercises and Core strengthening exercises, this comparative study aimed to determine the more effective intervention for young adults aged 18-24 years with chronic ankle instability having Cumberland Ankle Instability Tool score ≤ 25 . Outcome measures included Cumberland ankle instability tool and ankle goniometry recorded pre and post intervention.

Both group A and b were given an 8-week protocol PNF exercises and Core strengthening exercises respectively, the outcomes of both the group showed significant improvement in Cumberland ankle instability tool score and ankle goniometry score. These findings are supported by the systemic review and Meta-analysis by Luke Donovan and Jasper S.de Vries et al., which included 10 randomized controlled trials and given the validation to the use of Cumberland ankle instability tool,

star excursion balance test, joint position repositioning test and ankle goniometry, this study has used the two parameters as outcome measures.

Core strengthening primarily promote trunk and pelvic musculature alignment, which are very important for postural control and lower limb stability. Strengthening these proximal structures through exercises helps in improvement of neuromuscular co-ordination between trunk and lower limb, thereby it helps in reduction of unnecessary compensatory ankle movements and recurrent sprains. Improved core activation increases intra-abdominal pressure and helps the motor pathways, leading to effective muscle fibres recruitment timing and indirect ankle stabilisation. Moreover, it also improves central nervous system integration of vestibular, visual, and proprioceptive inputs. A stable core allows more systematic and effective processing of ankle sensory feedback, improving overall balance and joint sense.

PNF exercises involve multiplanar patterns of movement with joint compression and traction that stimulate muscle. While PNF improves strength, co-ordination and pain it may not sufficiently improve the working of precise sensory receptors required to improve for normalise ankle joint position sense. Given the multiple complications in chronic ankle instability including neural, mechanical, and muscular impairments PNF may not provide the specific effect needed at talocrural and subtalar joints. PNF exercise provide more of generalised strength and coordination rather than fine proprioceptive control needed for rapid stabilisation during unpredictable activities.

CONCLUSION

The present study conducted, compared the effects of PNF exercises and Core strengthening exercises in young adults with chronic ankle instability, using validated outcome measures. After 8 weeks of structured protocol, both the groups showed

statistically significant improvements across all the outcome measure. This has confirmed that both approaches are beneficial in addressing the negative effects of chronic ankle instability.

However, the statistical significance observed in functional improvements and self-reported ankle function and feeling of ankle “giving way” was more predominant in core strengthening exercise group. An 8-week core strengthening protocol was done on stable and unstable surfaces showed positive ankle range of motion in plantar flexion, dorsiflexion, inversion, and eversion. It also has showed the positive effect of static and dynamic balance by improving alignment.

Declaration by Authors

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Conflict of Interest: No conflicts of interest declared.

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