

A reciprocal inhibition-based maneuver for acute muscle cramps: A prospective observational study

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Abstract:

Problem Statement: Both athletes and non-athletes are prone to muscle cramps. The management techniques range from medication to various conventional approaches, most commonly aimed at stretching the muscle cramping; however, optimal outcomes are not always guaranteed. This study examines the use of a reciprocal inhibition-based maneuver for acute cramp management. **Approach:** 20 participants with active cramps were treated by a specialist using the Contract → Reciprocal Contract technique, consisting of sustained contraction of the antagonist muscle to counteract the cramp-induced contracted agonist. Pain intensity was assessed using a Visual Analog Scale (VAS) before and after intervention, functional mobility was recorded, and qualitative feedback was collected. Follow-up was performed at one week to assess recurrence. **Results:** Median pain scores decreased from 7 (IQR 6–8) to 0 (IQR 0–1) following CRC (Wilcoxon signed-rank test, $p < 0.0001$). Functional mobility was preserved in all participants, with 85% reporting no restriction. At one-week follow-up, only 55% experienced occasional episodes, but these resolved with repeat CRC application. Qualitative feedback highlighted surprise at effectiveness, convenience, and curiosity about the mechanism. Secondary analyses suggested that intervention type and baseline pain severity were associated with recurrence rates ($p = 0.04$ and $p = 0.02$, respectively). **Conclusion:** The CRC maneuver was associated with rapid and substantial pain reduction in all participants within the cohort, with no adverse events reported. While preliminary findings suggest feasibility within physiotherapy and sports settings, further randomized controlled trials with larger samples and extended follow-up are warranted.

Keywords: Reciprocal inhibition; Ia interneuron; Muscle spindle; Antagonist inhibition; Neuromuscular control; Muscle cramps; Contract–Reciprocal Contract (CRC).

Introduction

Both professional athletes and non-athletic older adults are susceptible to muscle cramps. By definition, these are sudden, involuntary, and painful contractions of any skeletal muscle (as opposed to smooth muscle, which is not under voluntary control). These contractions are often debilitating to the point that they impair movement and performance across diverse populations. A study carried out in an elderly population at a care centre in Australia reported an adjusted prevalence of 46% (Maisonneuve et al., 2016). In comparison, exercise-associated muscle cramps have been reported in 67% of triathletes, up to 70% of marathon runners, and up to 53% of American football players (Maughan & Shirreffs, 2019). Despite its prevalence, the precise underlying mechanism remains incompletely understood. Conventional treatments such as massages, stretching or even electrolyte replacement demonstrate variable effectiveness, and optimal management strategies remain debated. This is understandable because the aforementioned approaches primarily target mechanical or metabolic factors; yet mounting evidence points to a different etiology: a disturbed spinal reflex control (Giuriato et al., 2018; P. Schweltnus et al., 1997). Current evidence suggests that a transient phase of α -motor neuron hyperexcitability, combined with reduced inhibitory input, may contribute to cramp development (Miller et al., 2010).

Within the subject of neuromuscular physiology, an emphasis is put on the role of reciprocal inhibition in maintaining coordinated movement (Crone, 1993; Crone & Nielsen, 1989). To elaborate, it is a spinal reflex in which activation of an antagonist muscle suppresses its agonist (via Ia inhibitory interneurons) and this pathway is affected during states of fatigue and overload, leading to hyperexcitable muscles and the start of cramps. While reciprocal inhibition has been extensively studied in flexibility and motor control contexts, few studies have evaluated its deliberate activation as an acute management strategy for muscle cramps.

This study addresses that gap by evaluating a reflex-driven approach: the Contract → Reciprocal Contract (CRC) maneuver, a variation from the older contract-relax-antagonist-contract (CRAC) approach which follows the principles of proprioceptive neuromuscular facilitation (Millner et al., 2022; Ryan et al., 2010). To elucidate, CRC involves contracting the reciprocal antagonist muscle during an active cramp, with the intention of engaging reciprocal inhibition pathways and facilitating relaxation of the agonist muscle. This differs from conventional approaches, which often involve passive stretching of the affected muscle. This method has been

the norm for decades, but passive stretching during an active cramp has been reported to increase discomfort in some individuals. The primary objective of this study was to evaluate the association between CRC application and acute pain reduction during active muscle cramps. Additionally, a secondary objective was to review the neurophysiological basis and existing evidence in literature, to examine the extent of existing evidence supporting reciprocal inhibition as a therapeutic mechanism.

Literature Review

Neurophysiological Basis of Reciprocal Inhibition

Reciprocal inhibition can be defined as a spinal reflex mechanism that promotes smooth, coordinated movement by reducing antagonist muscle activity during agonist contraction. The entire process is mediated by Ia inhibitory interneurons, and these receive excitatory input from muscle spindle Ia afferents after which they transmit inhibitory signals to the α -motor neurons of the antagonist muscle (Crone, 1993; Crone & Nielsen, 1989). Although the reflex latency is extremely short (in the order of milliseconds), it enables rapid modulation of muscle activity during dynamic movement.

Role of Muscle Spindles and Golgi Tendon Organs

Muscle spindles, located within skeletal muscle, detect changes in muscle length and velocity. They provide excitatory input to α -motor neurons via Ia afferents. In contrast, Golgi tendon organs (GTOs), which are similar yet structurally different receptors, sense tension at the musculotendinous junction and follow-up with autogenic inhibition through Ib afferents. This ultimately reduces excessive force generation within the same muscle (P. Schweltnus et al., 1997; Sharman et al., 2006). Collectively, these sensory systems contribute to the regulation of excitation and inhibition. Fatigue and overload may disrupt this balance by diminishing GTO-mediated inhibition and amplifying spindle discharge, potentially contributing to a hyperexcitable state associated with cramp onset.

α -Motor Neuron Excitability and Cramp Pathophysiology

The α -motor neuron pool accommodates both excitatory and inhibitory inputs from peripheral receptors and spinal interneurons. When inhibitory influences (such as those from reciprocal inhibition) are compromised, α -motor neurons may enter a hyperexcitable state. This may result in sustained involuntary contractions, a characteristic feature of muscle cramps (Minetto et al., 2013). This is further reinforced by electromyographic studies confirming that cramping muscles exhibit high-frequency bursts distinct from voluntary contractions.

Therapeutic Implications of Reciprocal Inhibition

The underlying principle of the technique is grounded in established neuromuscular facilitation concepts, since interventions revolving around reciprocal inhibition have long been incorporated into proprioceptive neuromuscular facilitation (PNF) and muscle energy techniques (MET). Simply put, these management techniques focus on autonomic inhibition of muscles to promote relaxation of the agonist (Siddiqui et al., 2022). CRC applies this principle in the specific context of an active cramp episode by employing sequential activation of agonist and antagonist muscles with the intention of engaging reciprocal inhibition pathways and facilitating relaxation of the agonist muscle without passive stretching. Furthermore, unlike traditional CRAC protocols, CRC omits the relaxation phase and maintains continuous neuromuscular engagement during application (Miller et al., 2010).

Materials & Methods

Study Design

This study was designed as a prospective, single-arm observational trial conducted in a gym setting. Given the acute and unpredictable presentation of muscle cramps, a pragmatic single-arm design was selected to evaluate the feasibility and immediate symptom response. The primary objective was to evaluate the association between CRC application and immediate pain reduction during active muscle cramp episodes. The intervention was applied during actual cramp episodes, and outcomes were assessed through immediate and short-term patient feedback.

Participants

Twenty participants presenting with spontaneous or exercise-associated muscle cramps were recruited consecutively during routine gym attendance. Inclusion criteria were age ≥ 18 years and presentation with an active cramp episode during the visit. The exclusion criteria included severe musculoskeletal injury, neurological disorders, or inability to perform voluntary contractions. For every participant, demographic and clinical details (age, gender, cramp location, and precipitating factors) were recorded for each participant. Participants were not excluded based on sex, fitness level, or prior history of cramping.

Intervention

The CRC maneuver was administered by the same practitioner for all participants after explanation of the procedure and verbal informed consent. The protocol consisted of standardised positioning of the affected muscle followed by active contraction of the reciprocal antagonist. Participants were then instructed to perform a sustained contraction of the antagonist muscle for approximately 2–5 seconds, repeated as needed until cramp cessation. Cramp resolution was defined as participant-reported cessation of pain and visible relaxation of the affected muscle. Verbal cues and physical support were provided as needed to ensure correct execution.

Although the specific antagonist movement varied according to the affected muscle group, all applications adhered to the same reciprocal inhibition principle.

Data Collection

Data were collected in two phases. Pain intensity was recorded immediately before intervention and immediately following cramp resolution using a Visual Analog Scale (VAS, 0–10). Besides this, qualitative feedback was taken by recording the verbal responses from the participants. Participants were contacted one week following the intervention to assess recurrence and perceived functional status. All responses were documented in a structured table format.

Outcome Measures & Data Analysis

The primary outcome was change in the pain intensity from pre-intervention to post-resolution. Pain intensity was self-reported using a 0–10 Visual Analog Scale (VAS). The secondary outcomes included a number of parameters such as functional mobility post-intervention or any recurrence rate at follow-up (TABLE 1). Additionally, overall patient satisfaction was verbally recorded and presented as quotes.

Descriptive statistics were used to summarize participant characteristics and recurrence data. Pre- and post-intervention VAS scores were compared using the Wilcoxon signed-rank test due to non-normal distribution. Statistical significance was set at $p < 0.05$.

Ethical Considerations

All participants provided informed consent prior to intervention and data collection. The maneuver was considered low-risk and was performed as part of standard care. Confidentiality of patient responses was maintained throughout the study. The intervention was conducted in accordance with the principles of the Declaration of Helsinki.

TABLE I: Data Synthesis

Participant #	Age	Gender	Cause of Cramp	Location	Intervention	Pain before intervention (VAS)	Pain after intervention (VAS)	Functional mobility post-intervention	Feedback (Theme)	Follow-up after 1 week
1	43	M	Exercise (cycling)	Quadriceps	Contracted Hamstring	6	0	No restriction	Surprised at effect	No recurrence of cramps
2	56	M	Lying down	Foot arch	Contracted Anterior Tibialis	6	0	No restriction	Surprised at effect	No recurrence of cramps
3	38	M	Lying down	Calf	Contracted Anterior Tibialis	9	1	No restriction	Appreciates convenience	Few episodes of cramps; resolved after repeat maneuver at home
4	74	F	Sudden movement (whilst tying shoelaces)	Abdominals	Lay back and contracted Back muscles	5	1	No restriction	Just stating Relief	No recurrence of cramps
5	38	M	Exercise	Abdominals	Contracted Back muscles against a wall	5	0	No restriction	Curious about how it works or why it isn't more known	No recurrence of cramps
6	67	F	Exercise	Calf	Contracted Anterior Tibialis	9	0	No restriction	Curious about how it works or why it isn't more known	Few episodes of cramps; resolved after repeat maneuver at home
7	18	M	Exercise	Calf	Contracted Anterior Tibialis	8.5	2	Mild restriction	Appreciates convenience	Few episodes of cramps; resolved after repeat maneuver at home
8	54	M	Exercise (Pull-up)	Hamstring	Contracted Quadriceps	7	0	No restriction	Appreciates convenience	Few episodes of cramps; resolved after repeat maneuver at home
9	61	F	Exercise	Abdominals	Contracted Back muscles against a wall	5	0	No restriction	Surprised at effect	No recurrence of cramps
10	33	M	Walking	Calf	Contracted Anterior Tibialis	6	0	No restriction	Curious about how it works or why it isn't more known	No recurrence of cramps

11	35	M	Lying down	Foot arch	Contracted Anterior Tibialis	4	0	No restriction	Just stating Relief	No recurrence of cramps
12	F	42	Calf	Calf	Pulled toes up	7	0	No restriction	Curious about how it works or why it isn't more known	Few episodes of cramps; resolved after repeat maneuver at home
13	71	M	Exercise	Calf	Contracted Anterior Tibialis	7	0	No restriction	Appreciates convenience	Few episodes of cramps; resolved after repeat maneuver at home
14	60	M	Walking	Calf	Pulled toes up	7	2	Mild restriction	Just stating Relief	Few episodes of cramps; resolved after repeat maneuver at home
15	57	M	Exercise	Ribs/Intercostals	Twisted body in opposite direction	6	0	No restriction	Surprised at effect	No recurrence of cramps
16	29	M	Exercise	Calf	Contracted Anterior Tibialis	6	0	No restriction	Surprised at effect	No recurrence of cramps
17	33	F	Lying down	Foot arch	Pulled toes towards shin	9	0	No restriction	Just stating Relief	Few episodes of cramps; resolved after repeat maneuver at home
18	46	F	Lying down	Toes	Pulled toes towards shin	7	0	No restriction	Appreciates convenience	Few episodes of cramps; resolved after repeat maneuver at home
19	21	M	Exercise (Swimming)	Calf	Pulled toes towards shin	7.5	2	Mild restriction	Surprised at effect	Few episodes of cramps; resolved after repeat maneuver at home
20	29	M	Exercise (Lunges)	Hamstring	Contracted Quadriceps	6	2	Mild restriction	Surprised at effect	No recurrence of cramps

Results

Participant Characteristics

A total of 20 participants were enrolled in the study. The mean age was 46.6 years (SD = 15.6, range 18–74), with 65% male participants. Etiology-wise, the majority of cramps were exercise-related (65%), followed by episodes occurring while lying down (25%) and walking (10%) (FIGURE 1). The most common cramp location was the calf (45%), but other sites were also reported, including the abdominals (15%), foot arch (15%), hamstring (10%), quadriceps (5%), ribs/intercostals (5%), and toes (5%) (FIGURE 2). The specific antagonist contraction varied according to cramp site; the anterior tibialis was addressed most frequently (45%), followed by toe-pulling maneuvers (25%), back muscle contraction (15%), quadriceps contraction (10%), and trunk twisting (5%).

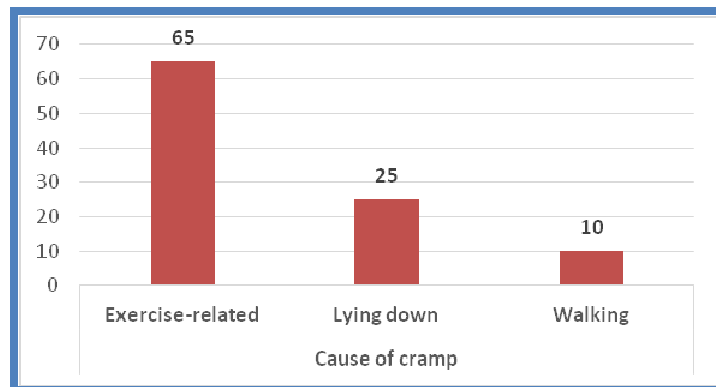


FIGURE 1: Etiology of Cramps (percentage)

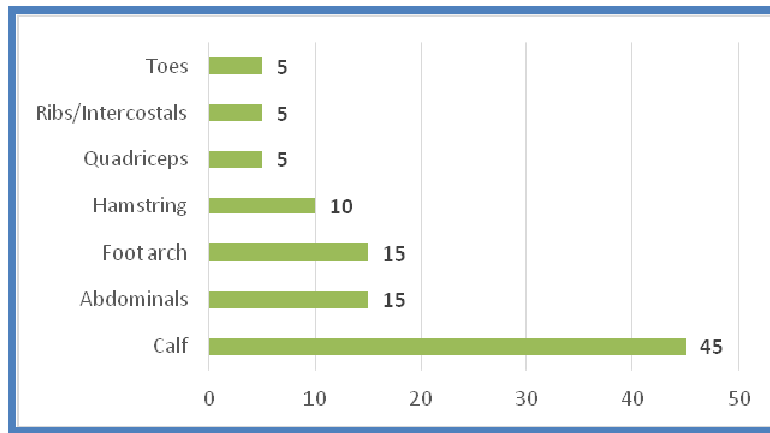


FIGURE 2: Location of Cramps (percentage)

Pain Scores

On the main outcome, pain intensity decreased markedly following the CRC maneuver (TABLE 2). The mean baseline pain score was 6.65 (SD = 1.4), with a median of 7 (IQR 6–8). After intervention, the mean pain score fell to 0.4 (SD = 0.7), with a median of 0 (IQR 0–1). The Wilcoxon signed-rank test confirmed this reduction was highly significant ($p < 0.0001$).

TABLE 2: Pain comparison before and after intervention

Pain (VAS)	Mean $\pm$ SD	Median (IQR)
Before intervention	6.65 $\pm$ 1.4	7 (6–8)
After intervention	0.4 $\pm$ 0.7	0 (0–1)
Wilcoxon signed-rank test	$p < 0.0001$	Significant reduction

Functional Mobility and Follow-up

On the secondary outcomes, functional mobility was preserved in all participants (FIGURE 3). Indeed, seventeen individuals (85%) reported no restriction post-intervention, while only three (15%) experienced mild restriction. At one-week follow-up, nine participants (45%) reported no recurrence of cramps, whereas eleven (55%) experienced occasional episodes that resolved with repeat application of the CRC maneuver (FIGURE 3).

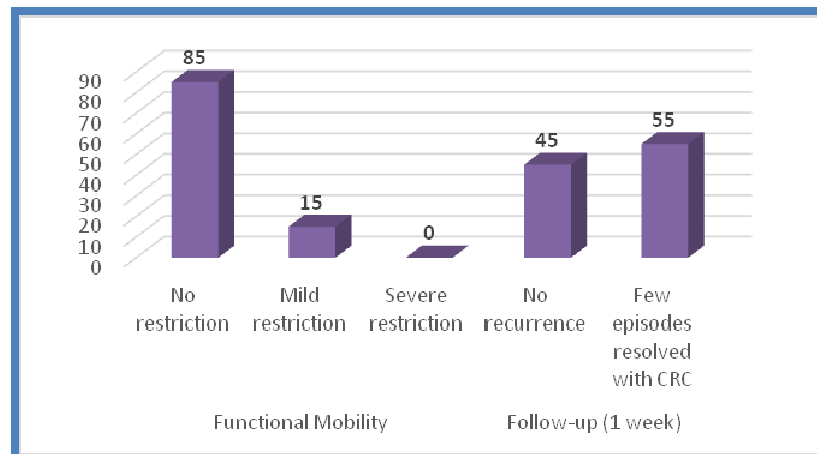


FIGURE 3: Mobility and Follow-up Cramps (percentage)

Patient Feedback

The majority of participants verbally gave positive feedback (FIGURE 4). Qualitatively, the feedback was categorized into four themes (Figure 4). Six participants (30%) expressed surprise at the effectiveness of the technique, five (25%) appreciated its convenience, another five (25%) were curious about the underlying mechanism and why it was not more widely known, and four (20%) simply reported relief without elaboration.

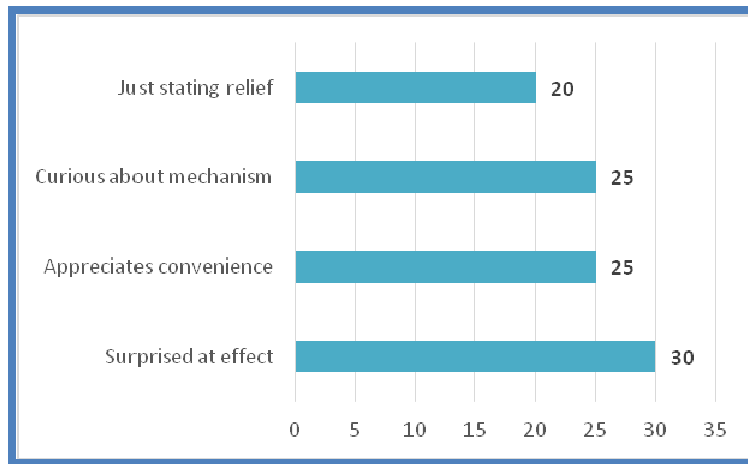


FIGURE 4: Qualitative feedback on intervention (percentage)

Secondary Analysis

Further analysis was conducted to explore predictors of recurrence (TABLE 3). Intervention type was significantly associated with recurrence ($p = 0.04$). Back muscles and quadriceps contractions were associated with sustained resolution in this cohort. In contrast, anterior tibialis and toe-pulling maneuvers were more frequently associated with repeat application. Baseline pain severity was also significantly associated with recurrence: participants with recurrence had higher initial pain scores (mean 7.5) compared to those without recurrence (mean 5.6, $p = 0.02$). Lastly, functional mobility restriction showed a non-significant trend ($p = 0.09$).

TABLE 3: Secondary Analysis

Comparison	Result	Test	p-value	Interpretation
Intervention type vs. recurrence	Back muscles and quadriceps contractions = 0 recurrence Anterior tibialis & toe-pulling = higher recurrence	Chi-square	0.04	Intervention type associated with recurrence
Baseline pain vs. recurrence	No recurrence: mean VAS = 5.6 Recurrence: mean VAS = 7.5	Mann–Whitney U	0.02	Higher baseline pain associated with recurrence
Functional mobility vs. recurrence	Mild restriction only in recurrence group	Fisher’s exact test	0.09	Non-significant trend ($p = 0.09$)

Discussion

This study provides preliminary evidence that the CRC maneuver was associated with rapid and consistent relief from acute muscle cramps across a modest yet varied sample group. A key finding was the marked decrease in pain intensity following the intervention without any compromise or deterioration of functional mobility. Importantly, participants consistently reported positive feedback, which ranged from surprise at the effectiveness to appreciation of its convenience. While the relief experienced by the participants was maintained at follow-up, those with higher initial VAS scores more frequently required a repeat session for complete remission. This was easily done independently by the participant at home, underscoring the convenience and acceptability of the approach.

The observed efficacy of CRC can be explained by its underlying neurophysiological basis. To reiterate, muscle cramps are widely understood to result from hyperexcitability of α -motor neurons, which are often triggered by fatigue or even overload. This leads to a lessened inhibitory input from spinal reflexes. Reciprocal inhibition, mediated by Ia interneurons, normally ensures smooth coordination by suppressing agonist activity during antagonist contraction. It should be noted that there is a distinction between reciprocal inhibition and reciprocal facilitation (Xia & Rymer, 2005). The latter is often pathological in etiology, such as in cases of spinal injury, resulting in the aberrant regrowth of nerve fibres to the muscles, but further explanation is beyond the scope of this study. CRC is designed to engage reciprocal inhibition pathways and may facilitate restoration of inhibitory balance. This mechanism may contribute to the termination of cramps without reliance on passive stretching or any form of external manipulation. This reflex-driven approach distinguishes CRC from conventional methods such as massage, electrolyte replacement, or static stretching.

The reciprocal inhibition pathway itself can be augmented to improve outcomes. Though it was not directly assessed in this study, literature shows how certain maneuvers and trainings can affect the pathway. A study by Floeter et al. looked at 16 healthy adults and trained them to perform a wrist flexion and extension task (Floeter et al., 2013). This was done by operating a mouse cursor on screen and moving it between targets. This

was done daily as a routine for 15 minutes until reaching the acquisition criterion. The authors then assessed the surface EMG recordings from wrist flexor and extensor muscles. Results showed reduced co-contraction once acquisition was achieved, meaning short-latency reciprocal inhibition was enhanced during the late-extension phase in the final session. It is hypothesized that if similar training is given to people who ultimately experience cramps, the CRC approach may be more impactful, but this remains to be tested.

Another study did something similar except this time the participants underwent explosive strength training (Geertsens et al., 2008). Geertsens et al. put 14 healthy human subjects in explosive strength training of the ankle dorsiflexor muscles 3 times a week for 4 weeks. Assessment was done at baseline, shortly after completion of all sessions, and at follow-up. It was found that the rate of torque development increased by 24–33% ($P < 0.05$). With respect to the reciprocal inhibition, this was measured as the depression of the soleus muscle reflex following conditioning stimulation of the peroneal nerve. At the onset of dorsiflexion, the amount of reciprocal inhibition increased significantly from 6% before the training to 22% after the training ($P < 0.05$). While it is understood not every person is suited for explosive strength training, these findings raise the possibility that neuromuscular training interventions could influence reciprocal inhibition pathways. However, this remains to be tested. Such adaptations may enhance the effectiveness of CRC if cramps occur. The CRC method may therefore provide more immediate relief. The method may complement appropriate muscle training or conditioning.

Limitations

This study is not without shortcomings. Firstly, the sample size was small given the single-arm observational design. None of the 20 participants were lost to follow-up. Secondly, reliance on self-reported outcomes may have introduced potential bias. Thirdly, recurrence data was only limited to one-week follow-up; it is unknown whether certain participants re-experienced cramps beyond the 1-week follow-up period. The absence of a control or comparator group limits causal inference regarding CRC efficacy.

Conclusion

The CRC maneuver was associated with immediate symptom relief within this cohort. No participant experienced any adverse effect during its execution, and all were accepting of it. The simplicity and safety of the maneuver make it a promising candidate for integration into physiotherapy practice and athletic training protocols. However, future studies should include randomized controlled trials with larger cohorts and longer follow-up periods to strengthen methodological rigor, validate these findings, and establish comparative efficacy against conventional treatments.

Declarations: There was no use of AI or AI assisted technologies in the writing process

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