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Comparing the Effectiveness of Soft Tissue Manipulation and IASTM for Calf Muscle Tightness in Spastic Cerebral Palsy Children

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Abstract: This experimental study aimed to assess the effectiveness of soft tissue manipulation and Instrument Assisted Soft Tissue Mobilization (IASTM) in alleviating calf muscle tightness in children diagnosed with spastic cerebral palsy (CP). Cerebral palsy, a condition affecting two to three out of every 1,000 live births, encompasses a range of challenges related to movement, posture, gait abnormalities, and balance issues. Specifically, spastic diplegic cerebral palsy, characterized by leg spasticity, often results in walking difficulties, with tiptoeing as a common symptom due to calf muscle tightness. The study involved 30 children aged 5-12 diagnosed with spastic cerebral palsy at ACS Medical College and Hospital. Participants meeting the inclusion criteria were divided into two groups: Group receiving soft tissue manipulation and Group B undergoing IASTM. Outcome measures included goniometry and the Modified Ashworth Scale. Random sampling was employed to select subjects, with exclusions for specific medical conditions. Written consent was obtained and demographic data were collected. Based on goniometry and the Modified Ashworth Scale, both interventions demonstrated highly significant differences in mean values within their respective groups. The findings underscore the potential efficacy of both soft tissue manipulation and IASTM in addressing calf muscle tightness in children with spastic cerebral palsy.

Introduction

The field of cerebral palsy (CP), a neuromotor disorder, has seen significant advancements in understanding and managing the condition (Agarwal and Verma, 2012). CP disrupts movement, muscle tone, and posture due to non-progressive disturbances in the developing brain, making it the second most prevalent neuro impairment in childhood, affecting 1.5 to 3 per 1,000 live births (Agarwal and Verma, 2012). Risk factors include congenital brain malformations, low birth weight, maternal-fetal infections, and preterm birth. Diagnosis often involves the observation of primitive

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reflex persistence beyond expected ages, prompting suspicion when motor milestones are delayed.

In infants, early signs of CP include poor neck control and leg scissoring, while older infants may struggle to bring hands together or rollover. The classification of CP includes spastic (80% of cases), dyskinetic, ataxic, or mixed types. Spastic CP, resulting from motor cortex or white matter damage, manifests as increased muscle tone, predominantly in lower limbs, with variations such as diplegia, hemiplegia, or quadriplegia (Armand et al., 2016). Dyskinetic CP, linked to basal ganglia lesions, presents with fluctuating tone, involuntary movements (writhing, jerky), and an altered sense of balance (Pisirici et al., 2021), leading to a dancing or athetoid gait. Ataxic CP involves balance and coordination issues, resulting in clumsy movements, poor fine motor skills, and an unsteady, ataxic gait (Das et al., 2022).

Clinical gait analysis is a valuable tool for understanding gait abnormalities in individuals with CP, providing an objective means of identifying and comprehending these issues (Armand et al., 2016). While it may not offer specific treatment guidelines, it contributes to a better understanding of the nature and extent of gait abnormalities. Various therapeutic options are available to address these gait abnormalities, with treatments aiming to minimize subsequent deformities, restore the use of the lever arm, and maintain muscle strength (Das et al., 2022).

One notable therapeutic approach is instrument-assisted soft tissue mobilization (IASTM) (Cheatham et al., 2019). This technique involves the use of instruments to manipulate soft tissues (Jo et al., 2023), breaking up scar tissue, mobilizing muscles (Stevenson et al., 2023) and enhance healing processes (Croft et al., 2022). Studies have demonstrated the effectiveness of IASTM in reducing spasticity (Bar-On et al., 2015) and improving upper extremity function in stroke rehabilitation (Shruti Deshpande et al., 2018). The neuro-mobilization approach employing IASTM has shown significant enhancement in the neuromuscular imbalance between tibialis anterior and gastrocnemius muscle activations, offering potential benefits in enhancing gait function in individuals with stroke (Lee et al., 2014).

Augmented Soft Tissue Manipulation (Astym) therapy, another therapeutic modality, has shown promise in addressing soft tissue disorders (Harris et al., 2019). Studies by Morad Chughtai et al. (2019) demonstrated notable improvements in flexibility, gait patterns, and motor function with the use of Astym therapy. Positive outcomes were also reported in the treatment of a child diagnosed with spastic diplegic cerebral palsy with improvements in muscular strength, flexibility and walking pattern (Miller et al., 2017). These findings highlight the potential of Astym therapy in enhancing motor function in individuals with CP. (Scheer et al., 2016) Aerobic exercise has also emerged as a beneficial intervention, particularly in improving quadriceps peak torque in children with spastic diplegia (Tamer El-Saeed et al., 2022). Virtual reality games and scalp acupuncture combined with acupuncture exercise therapy have shown favorable effects on motor performance in spastic diplegic CP patients (Akram Helmy et al., 2019; Yong Zhao et al., 2022). Additionally, studies exploring the benefits of single-stage multilevel soft-tissue surgery have reported positive outcomes in reducing lower-limb muscle tone and enhancing standing balance in children with spastic CP (Mohiuddin Aslam et al., 2022). As Susan Taylor et al. (2022) explored, the Wrist Position Sense Test has demonstrated construct validity and sensitivity to somatosensory training in children with CP, suggesting its potential as a valuable assessment tool. This highlights the importance of incorporating diverse therapeutic modalities to address the multifaceted challenges presented by CP.

The existing literature provides valuable insights into various therapeutic interventions and approaches for individuals with cerebral palsy (Orhan et al., 2018) and other musculoskeletal disorders (Cheatham et al., 2019; Das et al., 2022; Singh and Sharma, 2023; Khant et al., 2023; Stevenson et al., 2023; Liu and Wang, 2023). These interventions range from Astym therapy, task-oriented training, acupuncture and IASTM to surgical interventions, collectively contributing to understanding effective strategies for enhancing motor function, reducing spasticity and improving overall functional ability. Future research and psychometric investigations are recommended for further validation and refinement of these therapeutic approaches (Basak, 2019; Das et al., 2022; Stevenson et al., 2023; Liu and Wang, 2023). This study specifically investigated the effectiveness of soft tissue manipulation (Lee et al., 2021) and IASTM in addressing calf muscle tightness among children with spastic cerebral palsy, aiming to assess the potential benefits of these interventions to improve overall functional capabilities, enhance the quality of life, and foster a more active and independent lifestyle (Nazary-Moghadam et al., 2023).

In summary, the diverse array of therapeutic modalities reviewed, ranging from Astym therapy, task-oriented training, acupuncture and IASTM to surgical interventions, collectively contribute to understanding effective strategies for enhancing motor function, reducing spasticity, and improving overall functional ability in individuals with cerebral palsy and musculoskeletal disorders (Das et al., 2022; Stevenson et al., 2023; Liu and Wang, 2023). Future research and psychometric investigations are recommended to further validate and refine these therapeutic approaches. This study specifically investigated the effectiveness of soft tissue manipulation and Instrument-Assisted Soft Tissue Mobilization (IASTM) in addressing calf muscle tightness among children with spastic cerebral palsy, aiming to assess the potential benefits of these interventions to improve overall functional capabilities, enhance quality of life and foster a more active and independent lifestyle.

In conclusion, the holistic approach to cerebral palsy management involves a combination of therapeutic modalities tailored to individual needs. From instrument-assisted soft tissue mobilization (Cheatham et al., 2019) and Astym therapy (Harris et al., 2019) to aerobic exercise (Tamer El-Saeed et al., 2022) and virtual reality games (Akram Helmy et al., 2019), these interventions showcase the multidisciplinary nature of CP care. The references, including the studies by Das et al. (2022), Stevenson et al. (2023), and Liu and Wang (2023), provide a robust foundation for future investigations. This study, focusing on the impact of soft tissue manipulation and IASTM on calf muscle tightness in spastic cerebral palsy, contributes to the evolving landscape of therapeutic approaches for enhanced functional outcomes and improved quality of life.

CONSORT CHART

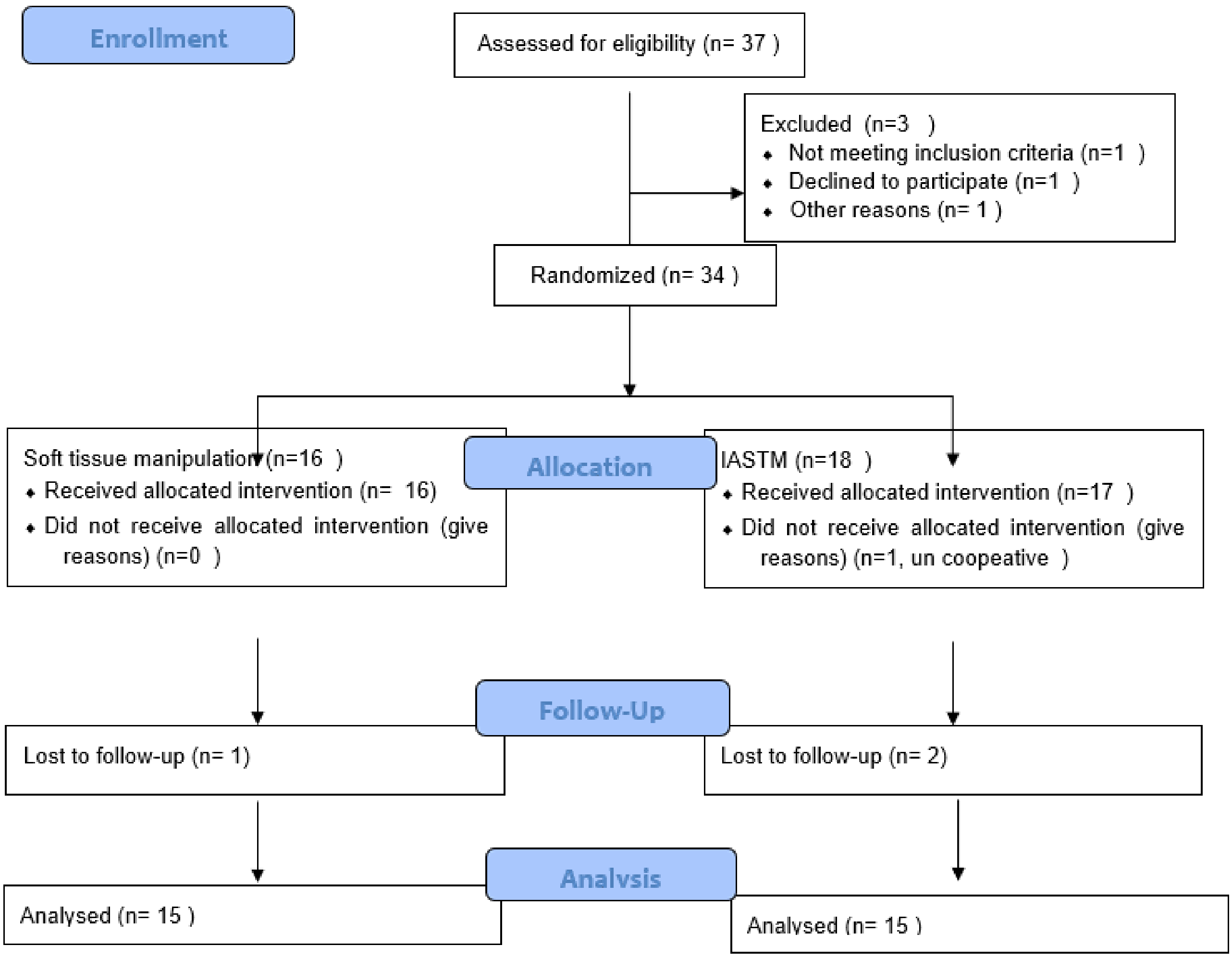

Figure 1. Consort Chart.

Methodology

Carried out at the physiotherapy outpatient department of ACS Medical College and Hospital, this experimental study employed a comparative design, focusing on pre- and post-intervention assessments spanning an 8-week duration. The sample consisted of 30 subjects, aged 5 to 12 years, diagnosed with spastic cerebral palsy, characterized by calf muscle tightness and associated walking difficulties. Utilizing a simple random sampling method (Excel) and single-blinded study, subjects were selected based on specific inclusion criteria. Pretest measurements encompassed the assessment of spasticity using the Modified Ashworth Scale (Syed et al., 2023) and ankle joint range of motion employing a goniometer. (Ashton et al., 1978) and Mutlu et al., 2008) Comprehensive informed consent and demographic data were diligently collected.

Figure 2. Group A receiving kneading.

Subsequently, the subjects were allocated into two groups: Group A received soft tissue manipulation, while Group B underwent Instrument-Assisted Soft Tissue Mobilization (IASTM), with both interventions administered for 15 minutes, five days a week, over the 8 weeks. All the therapists involved in this research had at least 5 years of experience in the specific field. The intervention for Group A involved the application of thumb and knuckle kneading techniques with distal pressure. In contrast, Group B received IASTM, employing long scanning and separation techniques. Post-test values, assessed through the Modified Ashworth Scale (Syed et al., 2023) and goniometer, were meticulously recorded after the 8-week intervention period. The study's detailed interventions, which included passive calf stretching (Looney et al., 2011) and ankle toe movements (Davids et al., 2010), were purposefully designed to evaluate the efficacy of soft tissue manipulation and IASTM in effectively addressing calf muscle tightness among children diagnosed with spastic cerebral palsy. (Simatou et al., 2020).

Results and Discussion

Demographic data underwent descriptive data analysis. Analysis of variance (ANOVA) using the latest version of SPSS software was employed for statistical modeling and associated estimation procedures, examining variations among and between groups to analyze mean differences. Additionally, paired t-tests were conducted for both groups.

Figure 3. Group B receiving IASTM.

The table presents pre-test and post-test results for four different measurements in Group A, assessing various parameters related to range of motion and muscle stiffness. The measurements include R-Goniometer, L-Goniometer, R-MAS (Muscle Activity Score), and L-MAS. For each measurement, the table displays the mean values, number of pairs, mean differences, standard deviation (SD), standard error of the mean (SEM),

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Table 1. Group A: Soft tissue manipulation.

Group A		Mean	Mean Diff.	SD, SEM	DF	t	P value
R -Goniometer	Pre Test	19.07	2.73	1.033 0.2667	14	10.25	P<0001 ****
	Post Test	21.80					
L Goniometer	Pre Test	19.20	2.667	1.877 0.4847	14	5.502	P<0001 ****
	Post Test	21.87					
R MAS	Pre Test	3.600	.5333	0.5164 0.1333	14	4.00	P<0001 ****
	Post Test	3.067					
L MAS	Pre Test	3.600	6.00	0.6325 0.1633	14	3.674	P<0001 ****
	Post Test	3.000					

Table 2. Group B: Instrument-assisted soft tissue mobilization.

Group B		Mean	Mean Diff.	SD, SEM	DF	t	P value
R -Goniometer	Pre Test	19.20	11.7	3.936 1.016	14	10.89	P<0001 ****
	Post Test	30.27					
L Goniometer	Pre Test	19.27	9.733	5.311 1.371	14	7.098	P<0001 ****
	Post Test	29.00					
R MAS	Pre Test	3.467	1.600	0.9103 0.2350	14	6.808	P<0001 ****
	Post Test	1.867					
L MAS	Pre Test	3.400	1.533	0.8338 0.2153	14	7.122	P<0001 ****

degrees of freedom (DF), t-values, and corresponding p-values.

Significant differences were observed between pre-test and post-test values for all measurements in Group A. The p-values for each measurement are less than 0.05, indicating that the observed changes are statistically significant. The asterisks in the "Sig. Diff. (P<0.05)" column denote the level of significance, with "****" representing a highly significant difference. These findings suggest that interventions or treatments applied to Group A had a notable impact on the assessed parameters, leading to statistically significant improvements in range of motion and muscle stiffness.

Table 2 presents the results of paired t-tests assessing the impact of Instrument Assisted Soft Tissue Mobilization (IASTM) within Group B. The measurements include the Right Goniometer (R-Goniometer) and Left Goniometer (L-Goniometer) for eye movement, as well as the Right Modified Ashworth Scale (R MAS) and Left Modified Ashworth Scale (L MAS) for muscle stiffness.

The mean pre-test value for the R-Goniometer is 19.20, with a post-test value of 30.27. The paired t-test indicates a highly significant mean difference ($t = 10.89$, $p < 0.0001$), suggesting substantial improvement in right-eye movement after IASTM. Similarly, the L-Goniometer's mean pre-test value is 19.27 and the post-test value is 29.00, with a highly significant mean difference ($t = 7.098$, $p < 0.0001$), indicating significant improvement in left eye movement following IASTM.

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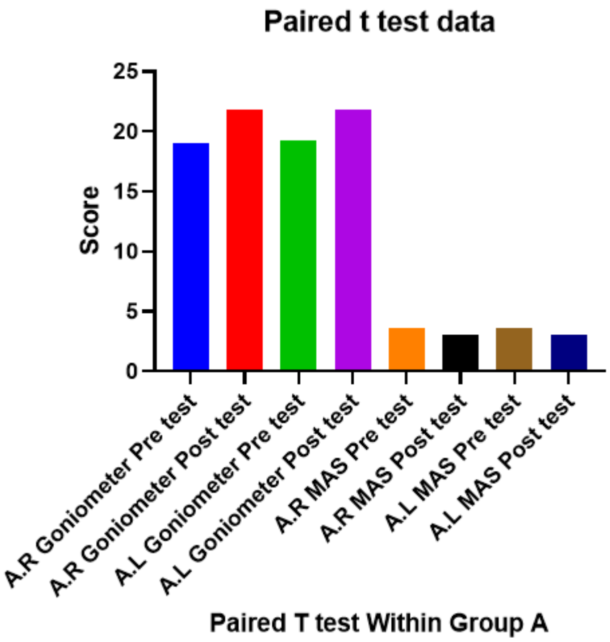

Figure 4. Presentation of Right- - Goniometer Pretest-Posttest, Left Goniometer Pretest, -Posttest, Right-Modified Ashworth Scale Pretest -Posttest, Left - Modified Ashworth Scale Pretest-Posttest within Group A.

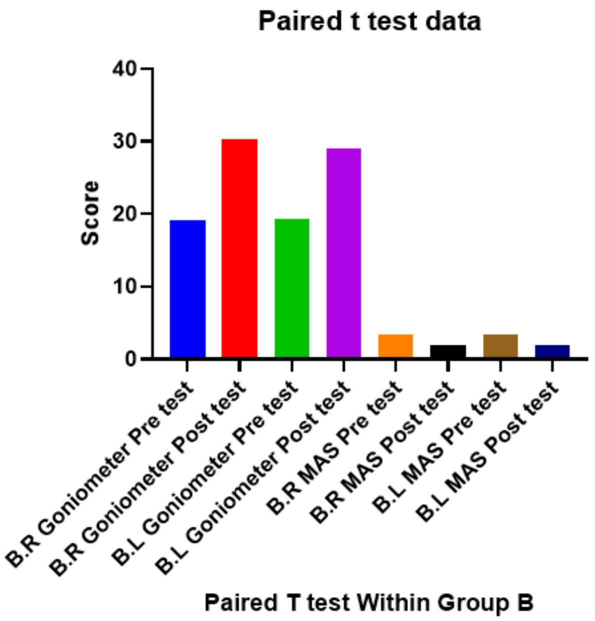

Figure 5. Presentation of Right - Goniometer Pretest-Posttest, Left Goniometer Pretest, -Posttest, Right-Modified Ashworth Scale Pretest -Posttest, Left - Modified Ashworth Scale Pretest-Posttest within Group B.

For R MAS, the pre-test mean value is 3.467, and the post-test value is 1.867. The paired t-test reveals a highly significant mean difference ($t = 6.808$, $p < 0.0001$), indicating a substantial reduction in muscle stiffness on the right side after IASTM. The pre-test mean value for L MAS is 3.400, and the paired t-test shows a highly significant mean difference ($t = 7.122$, $p < 0.0001$), suggesting a significant reduction in muscle stiffness on the left side following IASTM.

The results demonstrate that IASTM significantly affects eye movement and muscle stiffness within Group B. The statistically significant improvements observed in both goniometer measurements and MAS scores support the effectiveness of IASTM in enhancing these specific parameters related to soft tissue mobility and muscle tone (Myeong-Jun Kim et al., 2020).

Table 3 presents a comparative study between Group A, which underwent Soft Tissue Manipulation, and Group B, which received Instrument Assisted Soft Tissue Manipulation (IASTM). The analysis focuses on four outcome measures: Right Goniometer, Left Goniometer, Right Modified Ashworth Scale (R MAS), and Left Modified Ashworth Scale (L MAS).

Both groups show significant mean differences between pre-test and post-test values for the Right Goniometer. Group B demonstrates a notably higher mean difference, indicating a more substantial improvement in right-eye movement following IASTM. The R Square values suggest that the intervention in Groups A and B explains 13.71% and 56% of the variance in pre-test and post-test differences.

Similarly, the Left Goniometer results indicate significant mean differences in both groups, with Group B again showing a more pronounced improvement. The R Square values reveal that the intervention in Groups A and B explains 10.92% and 50% of the variance in pre-test and post-test differences.

Moving to the Right MAS, both groups exhibit highly significant mean differences, with Group B displaying a more substantial reduction in muscle stiffness. The R Square values suggest that 56% and 56.33% of the variance in pretest-post-test differences are explained by the intervention in Groups A and B, respectively.

In the case of Left MAS, both groups show highly significant mean differences, and Group B demonstrates a more significant reduction in muscle stiffness. The R Square values indicate that 56% and 56.33% of the variance in pretest-post-test differences are explained by the intervention in Groups A and B, respectively.

The ANOVA results underscore the effectiveness of both Soft Tissue Manipulation in Group A and Instrument Assisted Soft Tissue Manipulation in Group B. Group B, receiving IASTM, generally exhibits higher mean differences across all measures, suggesting a potentially more substantial impact on the assessed parameters compared to Group A. The findings provide valuable insights into the comparative effectiveness of the two interventions.

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Table 3. Comparative Study between Group A (Soft tissue manipulation) and Group B (Instrument ssisted Soft tissue manipulation).

Out come Measures	Exercise	Test	Mean	Mean Diff.	R Square	F	P value	Sig. diff. (P < 0.05)
R - Goniometer	**Group A**	**Pre test**	19.07	2.73	0.1371	2.967	0.0396	*
		Post Test	21.80					
	Group B	**Pre test**	19.20	11.7				
		Post Test	30.27					
L - Goniometer	**Group A**	**Pre test**	19.20	2.667	0.1092	2.287	P<0001	NS
		Post Test	21.87					
	Group B	**Pre test**	19.27	9.733				
		Post Test	29.00					
R -MAS	**Group A**	**Pre test**	3.600	.5333	0.5600	23.76	P<0001	****
		Post Test	3.067					
	Group B	**Pre test**	3.467	1.600				
		Post Test	1.867					
L- MAS	**Group A**	**Pre test**	3.600	.600	0.5633	24.08	P<0001	****
		Post Test	3.000					
	Group B	**Pre test**	3.400	1.533				
		Post Test	1.867					

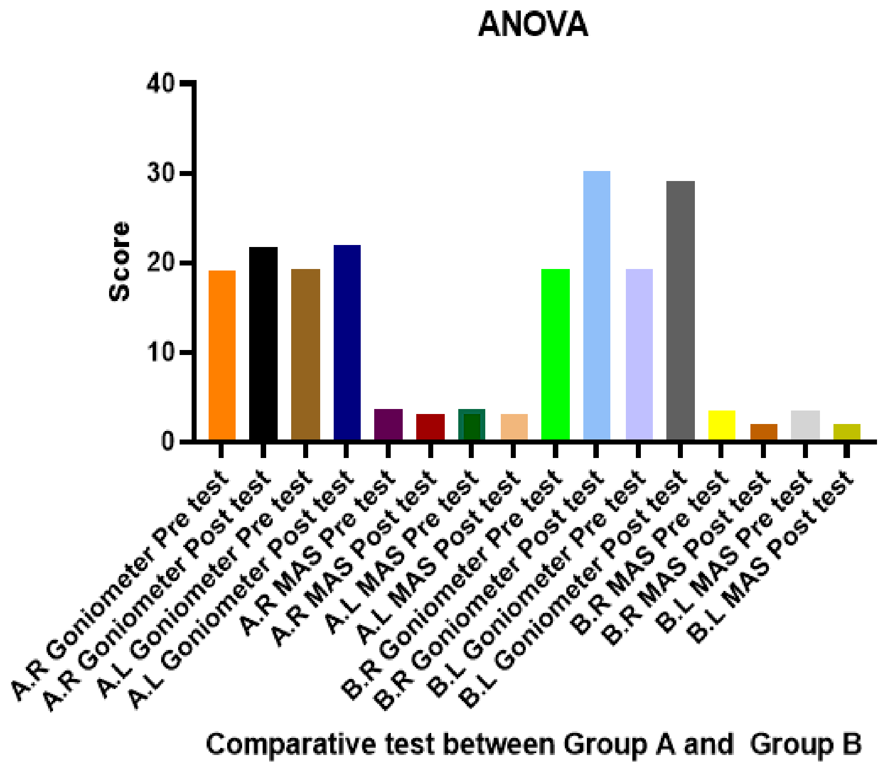

Figure 6. Presentation of Right- Goniometer Pretest-Posttest, Left Goniometer Pretest, -Posttest, Right- Modified Ashworth Scale Pretest -Posttest, Left- Modified Ashworth Scale Pretest-Posttest between Group A and B.

A total of 30 participants were selected for the study and evenly divided into Group A and Group B, with ages ranging from 5 to 12 years. In Group A, the Right and Left Goniometer Pretest-Post-test and Modified Ashworth Scale Pretest-Post-test significantly improved with mean differences of 3.80 and 8.667, respectively, and p values < 0.0001. Similarly, Group B exhibited significant improvements (mean differences: 2.73, 2.667, 0.533, 0.600, all p < 0.0001). A comparative study between the groups revealed significant differences in all measures (F values: 2.967, 2.287, 23.76, 24.08, all $p < 0.0001$). The study concluded that Group B was more effective, showing mean differences of 1.533, 1.600, 9.733, and 11.7 in Right Goniometer Pretest-Post-test, Left Goniometer Pretest-Post-test, Right Modified Ashworth Scale Pretest-Post-test, and Left Modified Ashworth Scale Pretest-Post-test, respectively. Cerebral palsy (CP) encompasses a spectrum of enduring movement and posture disorders, often resulting in activity limitations due to non-progressive disruptions during foetal or immature brain development.

The condition can manifest with motor disorders, sensory and perceptual disturbances, cognitive impairments (Bottcher et al., 2010), communication challenges, and secondary musculoskeletal problems. Risk factors such as preterm birth, intrauterine growth restriction, and multiple gestations can contribute to brain injuries leading to CP. Globally, the prevalence varies, with 1.5 to 3 cases per 1,000 live births, influenced by income levels and geographic regions. This study aimed to compare the efficacy of soft tissue manipulation and instrument-assisted soft tissue mobilization (IASTM) in addressing calf muscle tightness in children with spastic cerebral palsy. Both techniques were considered easy to implement, with IASTM noted for its slightly higher efficiency. IASTM demonstrated effectiveness in improving spasticity, enhancing range of motion (ROM) in ankle plantar flexion, and refining gait patterns, with no reported side effects. (Nadeem et al., 2023)

The research included 30 subjects, divided into Group A (soft tissue manipulation) and Group B (IASTM), each comprising 15 participants. Pretest and post-test assessments were conducted using goniometry and the modified Ashworth scale (MAS). Group A underwent soft tissue manipulation for eight weeks, while Group B received IASTM. The use of a universal stainless-steel tool in IASTM proved effective, distributing pressure evenly.

Noteworthy studies, including one by Sheer et al. (2016), demonstrated IASTM's positive impact on bilateral hamstring flexibility and Achilles tendinopathy in children with cerebral palsy. Instrument-Assisted Soft Tissue Mobilization (IASTM) has been shown to enhance the functioning of soft tissues and increase the range of motion in acute and chronic sports injuries. Additionally, it has the benefit of lowering discomfort (Kim et al., 2017). Soft tissue manipulation, aimed at reducing pain, muscle relaxation, and improving range of motion and strength, was employed in Group A. IASTM in Group B provided a mobilizing effect on soft tissue, addressing pain (Kini et al., 2020) and enhancing ROM and function. After eight weeks, statistical analysis indicated a significant effect in Group B ($P \leq 0.001$), supporting the alternate hypothesis.

Table 1 showed slight improvements in ROM for both right and left ankles and calf tightness in both groups, with MAS values remaining similar in the pretest and post-test. Table 2 highlighted significant improvements in calf muscle tightness using IASTM, especially in ankle ROM assessed by goniometry. Table 3 underscored significant differences in goniometer and MAS post-tests for both groups (soft tissue manipulation and IASTM), with P values < 0.0001. Both interventions demonstrated efficacy, but IASTM showcased superior results in reducing spasticity and improving ROM in children with spastic cerebral palsy and calf muscle tightness. In conclusion, both soft tissue manipulation and IASTM are widely used interventions for children with spastic cerebral palsy and calf muscle tightness. While both techniques yielded positive outcomes, IASTM emerged as more effective in this study, demonstrating superior results in reducing spasticity and enhancing ROM. This research contributes valuable insights into therapeutic interventions for individuals with cerebral palsy, potentially influencing future clinical practices.

Conclusion

This study concludes that, upon comparing soft tissue manipulation and instrument-assisted soft tissue mobilization, both techniques exhibited a substantial reduction in calf muscle spasticity and demonstrated improvement in ankle plantar flexion range of motion among children with spastic cerebral palsy. According to the findings of this study, Instrument-Assisted Soft Tissue Mobilization (IASTM) proves to be more effective than soft tissue manipulation in addressing these outcomes.

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Conflict of Interest

Nil declared by the authors.

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