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Effect Of Electrical Muscle Stimulation On Disuse Muscle Atrophy In Subdural Hematoma

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ABSTRACT

Background-Subdural hematoma (SDH) is a common intracranial haemorrhage associated with significant morbidity, often leading to prolonged immobilization and muscle atrophy. Disuse muscle atrophy, particularly in bedridden patients, results in loss of muscle mass and strength, impacting recovery and functional outcomes. Electrical muscle stimulation (EMS) has been explored as an intervention to mitigate muscle atrophy and enhance rehabilitation.

Aim-This study aimed to evaluate the effectiveness of electrical muscle stimulation in preventing disuse atrophy in patients with subdural hematoma, compared to passive range-of-motion exercises alone.

Methods-A total of 26 patients diagnosed with SDH and exhibiting muscle atrophy in the biceps brachii and quadriceps femoris were recruited. Participants were randomly assigned into two groups: Group A (EMS + Passive range of motion exercises) and Group B (Passive range of motion exercises only). The intervention was administered for six weeks, twice daily. Muscle girth measurements were recorded at baseline and post-intervention using circumferential measurements. Data were analysed using ANOVA and Kolmogorov-Smirnov tests.

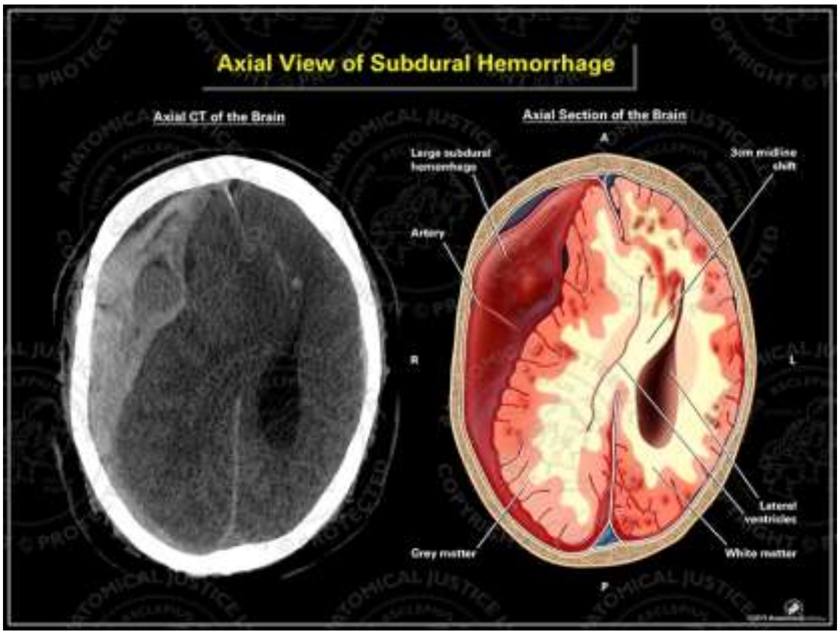
Results-Both groups showed significant improvement in muscle girth after six weeks ($p < 0.0001$). However, Group A demonstrated a significantly greater increase in muscle girth compared to Group B ($p < 0.0001$), indicating the superior effectiveness of EMS in preventing disuse atrophy.

Conclusion-Electrical muscle stimulation, in addition to early exercise training, is effective in reducing disuse muscle atrophy in patients with subdural hematoma. The findings suggest that EMS can be a valuable adjunct to conventional rehabilitation strategies for immobilized patients.

Keywords: *Electrical muscle stimulation, Disuse muscle atrophy, Subdural hematoma, Rehabilitation, Muscle girth.*

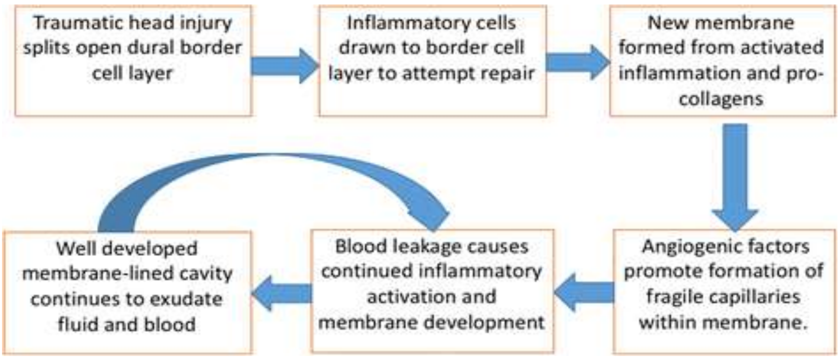
1. INTRODUCTION

Subdural hematoma (SDH) is one of the most frequent types of intracranial haemorrhage that is still associated with significant morbidity.SDH was considered progressive recurrent bleeding with a traumatic cause.(1)incidence of 1.7–20.6 per 100,000 persons per year and is more commonly encountered in the elderly population. The prevailing theory for developing subdural hematoma supports the tearing of cortical bridging veins, which traverse from the brain surface to the subdural space before they drain to the venous sinus.



Computed tomography (CT) head scan and schematic representation of a SDH

However, a subdural hematoma can also be caused by rupturing branches of superficial arteries and pial vessels inflammation can aid tissue repair, it is the *sustained* inflammatory response in SDH which results in new membrane growth and fluid accumulation over time. Damage to the dural border cells, rather than acute haemorrhage itself, may be what initiates this inflammatory response and may not



Occur in all patients, Possible complications includebrain herniation- Pressure in your brain can move tissue away from where it's supposed to be. This can lead to death.if someone have a head injury, Due to bedridden for the longer duration patient may developed significant muscle atrophy.Skeletal muscle is constantly adapting to its environment. It responds to stress by stimulating muscle development, and it responds to disuse with atrophy [(2)] Sarcopenia has been reported to affect 5-13% of persons aged 60 to 70 years and up to 50% of people over 80 years of age.Risk factors of sarcopenia are physical inactivity, hormone and cytokines imbalance, protein synthesis and regeneration, motor unit remodelling.

Extensive muscle atrophy is a common occurrence in patients who are bedridden or immobilized. The patients presenting with long-term consciousness disturbance for more than several months often experience remarkable lower limb motor dysfunction from muscle disuse, forcing them to use a wheelchair or impairing their activities of daily living. Dramatic reduction in muscle mass occurs within 4 to 6 weeks of bed rest and is accompanied by a decrease ranging from 6% to 40% in muscle strength [(3)] Disuse atrophy in the lower limbs of patients with consciousness disorder is often recognized as "an unavoidable consequence.

Electrical muscle stimulation (EMS) has been used in patients with severe chronic obstructive pulmonary disease and chronic heart disease [(5)] who could not exercise actively because of these conditions. Electrical muscle stimulation was useful in improving exercise capacity, skeletal muscle performance, and quality of life in these patients. alternative strategies should be defined to alleviate muscle wasting. Electrical stimulation (EMS) is an effective means to invoke involuntary muscle contractions.

studies suggested that early active contraction combined with ES can more alleviate muscle strength loss and atrophy through different modes of muscle activation [8] Moreover, some studies have shown a dose-response relationship between EMS treatment intensity and EMS effectiveness[8] i.e., the non-physiological high stimulation intensity and disordered recruitment of motor units caused by EMS may lead to rapid muscle fatigue and muscle injury[9]

Passive range-of-motion exercise help all the body's systems function properly. Furthermore, prolonged bed rest and mobilization may be beneficial to improving outcomes and facilitating early patient mobilization in critical care. It also helps prevent the negative effects of immobility, improve physical ability and consciousness levels. Several studies have revealed that muscle tension induced by passive motions can lead to higher HR by activating tendinous mechano-receptors and causing simultaneous muscle stretching and shortening, as in typical passive mobilization.

Based on these findings, we examined thecomparison between passiverange of motion exercises and preventive effect of EMS on disuse atrophy in the patients with subdural hematoma. The aim of this study was to evaluate muscle atrophy over a long period of bed rest and to elucidate whether disuse atrophy of the muscles in patients in coma can be prevented with EMS and passive range of motion exercisesin patients with traumatic brain injury (TBI) in the intensive care unit.

2. METHODS AND MATERIALS

Study design and setting

This is an experimental study conducted on patients with subdural hematoma having significant muscle atrophy in upper and lower limbs. This study was conducted in 2024, at Krishna College of Physiotherapy neuroscience ICU. Ethical committee clearance was obtained from the institution committee.

Participants –Participants who met the inclusion criteria were well-versed about the purpose and nature of the study and a written consent was taken.

Inclusion criteria- The study included the subjects who had subdural hematoma of age group between 40-60 years of age for 3months,these patients were on mechanical ventilator and having muscle atrophy of upper or/and lower limb.

Exclusion criteria- This study excluded patients with actual deep vein thrombosis, sensory impairments, skin conditions, joint dislocation, subluxation, extremities fractures.

First, we evaluated the natural atrophy of the bicepsbrachi muscle of upper limb and quadriceps muscles of lower limb in bedridden patients. In September 2024. 50 subjects were screened out of which 26 subjects met the selection criteria. Further, the subjects were divided into 2 groups, Group A andGroup B.13 subjects were used as the control group to whomonly passive exercises were performed to prevent atrophy and maintain joint mobility. Next, we evaluated the training effects of EMS. Remaining13 patients met the inclusion criteria. The sample size was calculated using Winpepi Software Version 11.38.

Outcome measure-

1. Circumferential Measurements**:** Use a measuring tape to measure the circumference of affected and unaffected limbs at specific landmarks.It has the reliability of >0.98. [10]
2. Serum Markers**:** Elevated creatine kinase (CK) or other markers may indicate muscle damage or changes. It has reliability of 0.58 [11]

Intervention-

Evaluation of the effect of EMS was performed weekly for 6 weeks. We evaluated 2 muscles of upper compartments of upper limb-biceps biceps, and lower compartments of the lower limb: quadriceps muscle. When paralysis of the lower limb or the level of consciousness improved and patients could move the lower limb voluntarily, EMS was stopped. Electrical muscle stimulation was performed daily starting 7days after admission.

Electrical muscle stimulation- Electrical muscle stimulation was performed for 30 minutes simultaneously on the upper limb (biceps brachii) and lower limb(quadriceps) of both extremities daily starting 7 days after admission. electrical muscle stimulator device was used to deliver the EMS. The output current of the device was set at 30 to 40 mA, and muscle contractions were confirmed visually. The duration of stimulation was 30 minutes, including 3 minutes for warm-up, 25 minutes for training, and 2 minutes for cool down. During the 25-minute training period, muscle stimulation was applied in cycles of 10 seconds, followed by a brief 10-second interruption.

Passive range of motion exercises- passive range of motion exercises like ankle toe movements, knee flexion- extension, abduction- adduction exercises, hip flexion-extension, abduction-adduction exercises were given to the subjects for 10-15 repetition with 2sets daily twice a day for 6 weeks. If one side of the patient's limb needed to be immobilized due to illness, only the healthy side of the lower limb was trained.

3. RESULTS

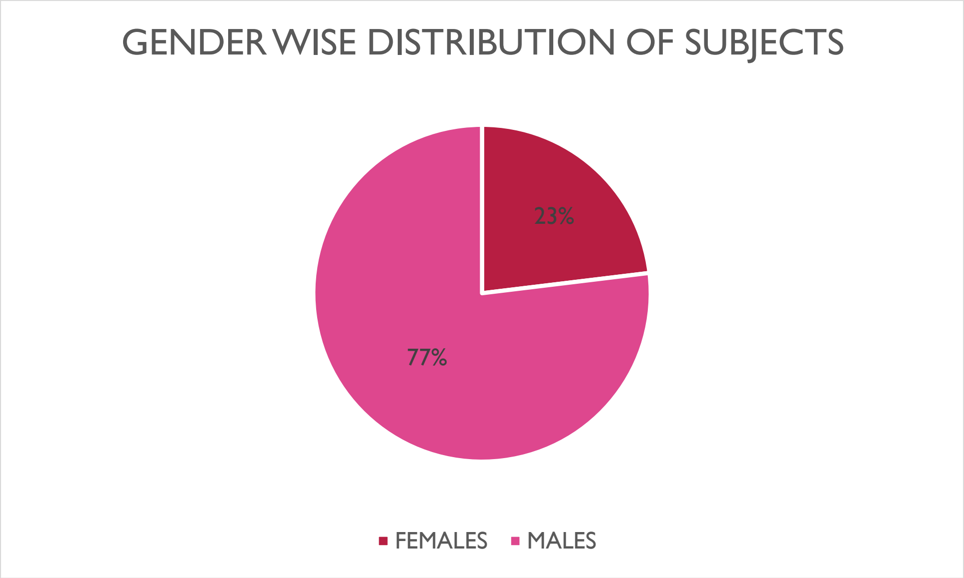
After the intervention, post assessment was done then statistical data were obtained regarding all the variables in the study and compiled on a MS Office Excel Sheet. The mean value and standard deviation data was used for Statistical Analysis, and it was carried out using ANOVA test.

Normality of the test was evaluated by Kolmogorov-Smirnov test. Paired sample t test was used to compare the pre and post variables. For the statistical test performed, a criterion of $p < 0.05$ was defined as statistically extremely significant.

Total 41 men and 26 women of age 40-60 years, with subdural hematoma volunteered to participate in the study, out of which 20 men and 6 women have completed six weeks of programmed.

Table no. 1 DEMOGRAPHIC DATA

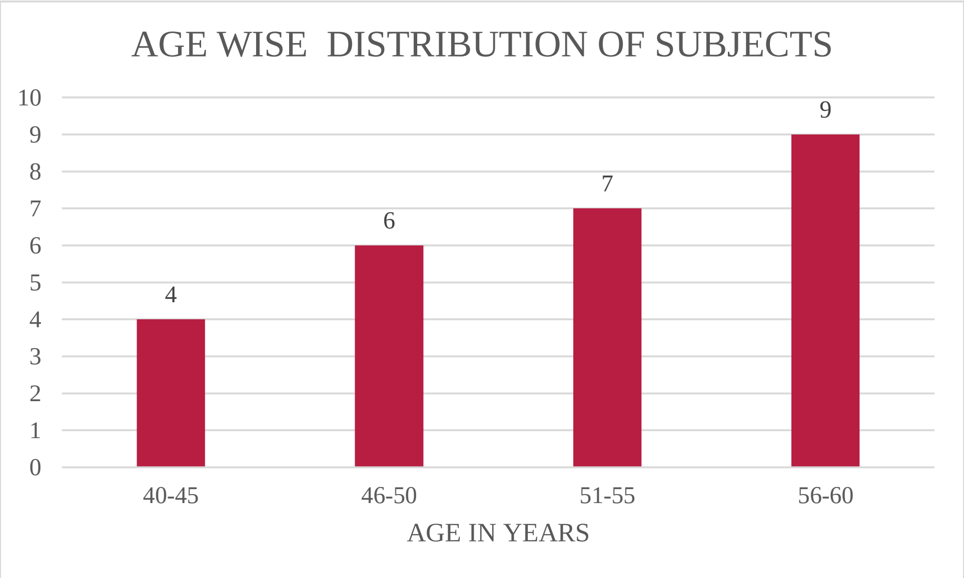
GENDER	TOTAL NO OF SUB JECTS
MALE	20
FEMALE	6



Graph no 1- Gender wise distribution of subjects in both the groups.

It shows that the proportion of male participants was more (77%) than female (23%) as shown in graph 1.

Age wise distribution	TOTAL NO OF SUB JECTS
40-45	4
46-50	6
51-55	7
56-60	9

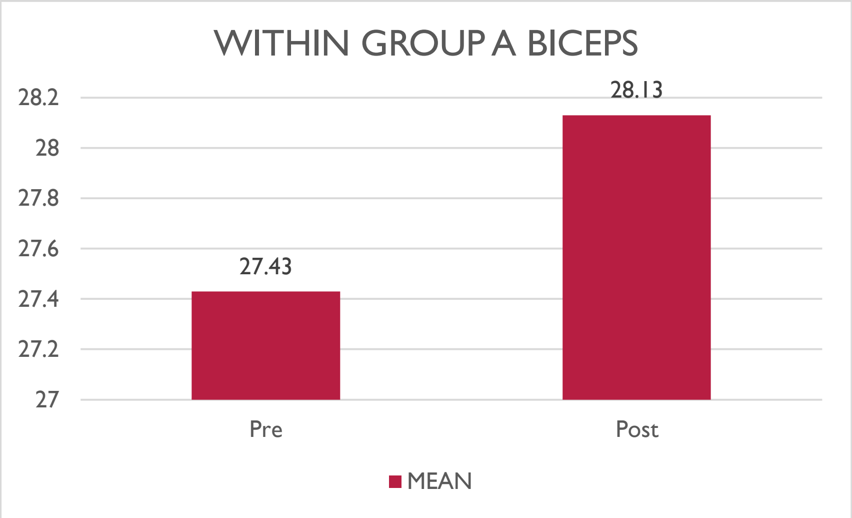


Graph no 2. Age wise distribution of subjects between both the groups.

The proportion of subjects between the age groups of 40-45years is 15%,46-50 years is 23%, 51-55 years is 27%, 56-60 years 35% as shown in graph 2.

Table no.2- Within group analysis of group A biceps muscle.

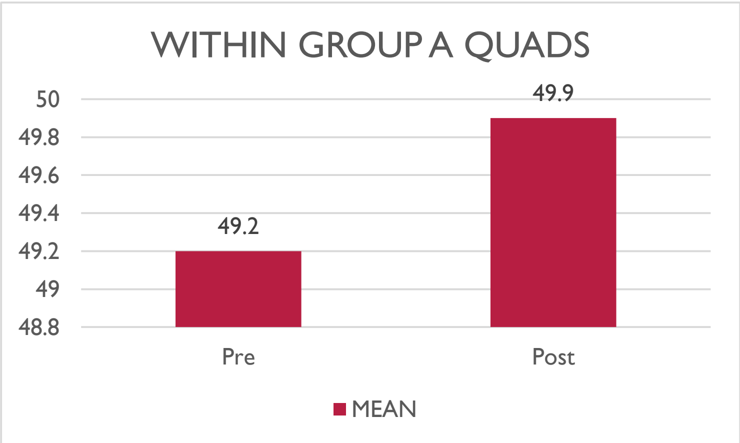
Group A (EMS+PASSIVE ROM) on biceps brachii muscle					
	Mean	SD	T value	P value	result
Pre	27.43	1.96	8.69	<0.0001	Extremely significant
Post	28.13	2.15			
Mean diff	-0.69				



Graph no .3- Graphical representation of within group A biceps, it shows statistically extremely significant with p value <0.0001.

Table no.3- Within group analysis of group A quadriceps muscle

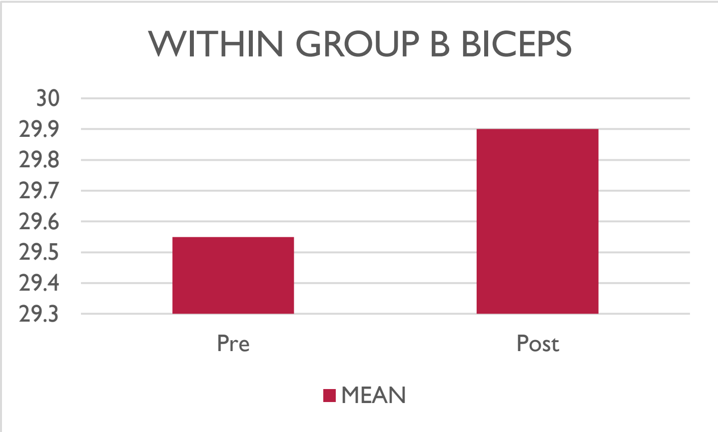
Group A (EMS +PASSIVE ROM) on Quadriceps muscle					
	Mean	SD	T value	P value	result
Pre	49.2	2.67	14.63	0.0001	significant
Post	49.9	2.62			
Mean diff	-0.69				



Graph no.4- Graphical representation of within group A quadriceps, it shows statistically significant with p value 0.0001.

Table no.4- Within group analysis of group B biceps muscle

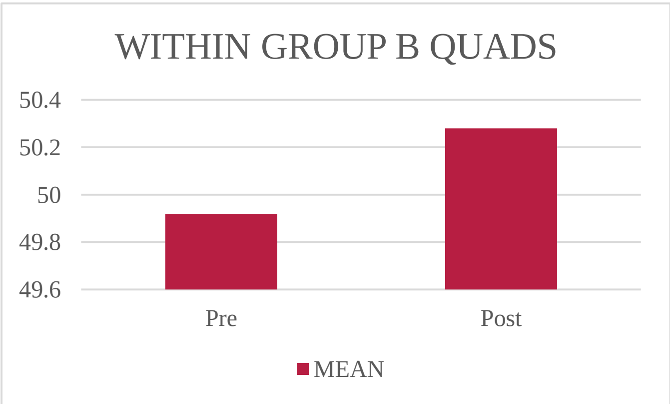
Group B (PASSIVE ROM) on Biceps muscle					
	Mean	SD	T value	P value	result
Pre	29.55	2.78	7.5	<0.0001	Extremely significant
Post	29.9	2.8			
Mean diff	-0.34				



Graph no .5- Graphical representation of within group B biceps, it shows statistically extremely significant with p value <0.0001.

Table no.5- Within group analysis of group B quadriceps muscle.

Group B (PASSIVE ROM) on Quadriceps muscle					
	Mean	SD	T value	P value	result
Pre	49.92	2.67	8.67	0.0152	significant
Post	50.28	2.63			
Mean diff	-0.36				

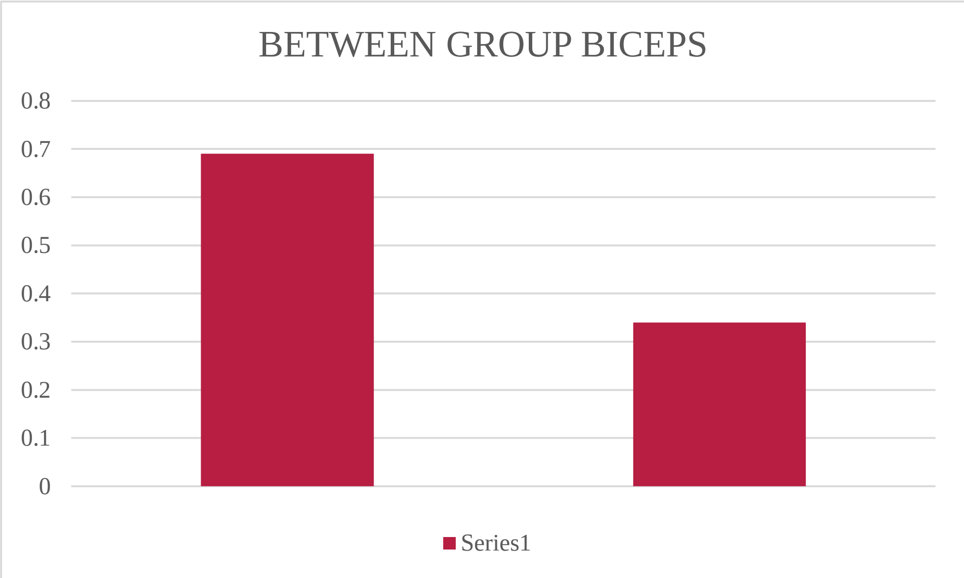


Graph no .6- Graphical representation of within group A biceps, it shows statistically significant with p value 0.0152.

4. BETWEEN GROUP ANALYSIS

Table no 6- Intragroup analysis of muscle girth in group A and group B biceps muscle respectively.

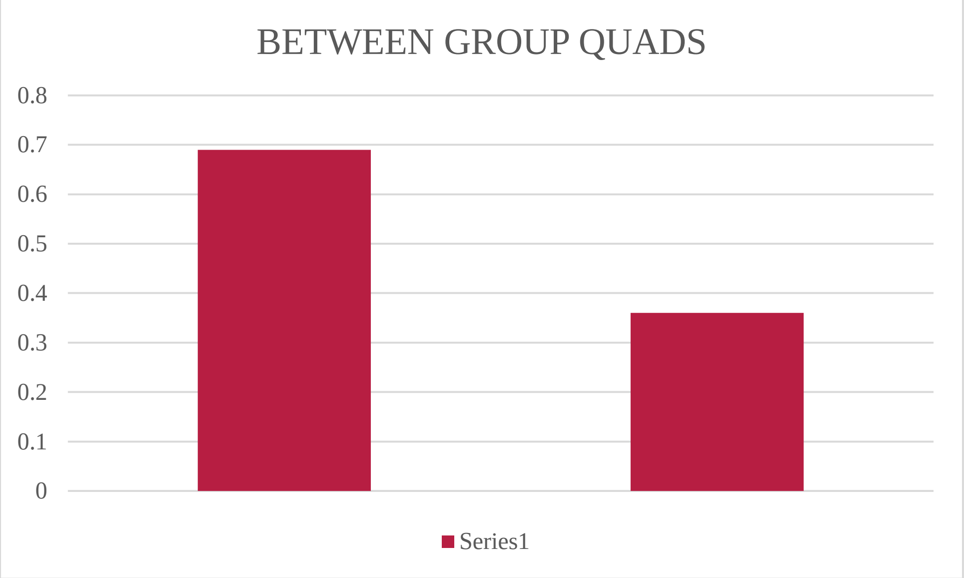
BETWEENS GROUP ANALYSIS OF DIFFERENCE OF MUCLE GIRTH IN BICEPS MUSCLE							
	N	Mean	SD	MEAN DIFF	T value	P value	result
GROUP A	13	0.69	0.28	-0.34	3.76	0.0001	Extremely significant
GROUP B	13	0.34	0.16				



Graph no. 7- Graphical representation of between group analysis of muscle girth between group A and B. It shows significantly improvement in muscle girth when compared between two groups i.e. group A and group B with p value of 0.0001, which indicates that group A is more effective in reducing muscle atrophy.

Table no 7- Intragroup analysis of muscle girth in group A and group B of quadriceps muscle respectively.

BETWEEN GROUP ANALYSIS OF DIFFERENCE OF MUCLE GIRTH IN QUADRICEP MUSCLE							
	N	Mean	SD	MEAN DIFF	T value	P value	result
GROUP A	13	0.69	0.17	-0.33	5.24	<0.0001	Extremely significant
GROUP B	13	0.36	0.15				



Graph no. 8- Graphical representation of between group analysis of muscle girth of quadriceps muscle between group A and B. It shows extremely significantly improvement in muscle girth when compared between two groups i.e. i.e. group A and group B with p value of <0.0001, which indicates that group A is more effective in reducing muscle atrophy.

5. DISSCUSION

The present study aimed to compare the effects of EMS andPROM exercises to prevent disuse muscle atrophy insubdural hematoma patients. The results demonstrated that both interventions significantly improved muscle mass;however,EMS with PROM exercises exhibited greater effect than conventional treatment.

In this study, we showed that use of EMS as an alternativeform of exercise haspreventive effect on lower limbatrophy from disuse in patients in coma resulting fromTBI with EMS.

Dreyer etal reported that the activity of the mammalian target ofrapamycin signalling pathway in human skeletal muscle isassociated with an increased rate of muscle protein synthesisduring the early recovery phase after a single bout ofresistance exercise [16]Another study found that in addition to early exercise training, NMES should be applied to prevent muscle atrophy for patients without nerve injury in ICU. Also, simultaneous NMES treatment on agonist/antagonist muscle can enhance the effect of preventing muscle atrophy. [17]

From this result, it is hypothesized that another mechanism of muscle protein synthesis different from that occurring during resistance exercise takes place when EMS is used.

Electrical muscle stimulation was well tolerated in the present study and has been used safely as a strength training tool in healthy subjects and athletes and as a rehabilitation and prevention tool for patients with chronic obstructive pulmonary disease and chronic heart disease for several decades.[18] In this study, transient slight elevation of serum creatine phosphokinase value was recognized, but they did not affect the general condition of patients (data not shown).Electrical muscle stimulation is an effective prevention of muscle atrophy from disuse in patients with conscious disturbance. We succeed in limiting the decrease in muscle atrophy as measured by cross-sectional area to within 4% by use of EMS for only 30 minutes per day during the 35-day study period

The findings of the present study may also be of great use in elucidating the mechanism of sarcopenia and in developing new treatments for this condition.

6. CONCLUSION

Electrical muscle stimulation is effective in the prevention of disuse muscle atrophy in patients with subdural hematoma. Electrical muscle stimulation treatment on agonist/antagonist muscle can enhance the effect of preventing muscle atrophy.

In this study, the use of EMS was limited to patients with first-time stroke or TBI. We hope to develop potential applications of EMS to those patients and to evaluate functional outcome of participants upon return from coma and ambulation in the. EMS should perform in all muscles. The surface muscle contractions were confirmed visually. We couldn’t confirm the contraction of deeper muscles, which we could not see from the electrical stimulation

REFERENCES

[1] Clinical Analysis of Risk Factors Related to Recurrent Chronic Subdural Hematoma Byung-Soo Ko, M.D., Jung-Kil Lee, M.D., Bo-Ra Seo, M.D., Sung-Jun Moon, M.D., Jae-Hyoo Kim, M.D., and Soo-Han Kim, M.D.

[2] Clinical cases in neurovascular diseases and traumatic brain injury Kostas Konstantopoulos, Dimitrios Giakoumettis,in Neuroimaging in Neurogenic Communication Disorders, 2023

[3] Takarada Y, Takazawa H, Ishii N: Applications of vascular occlusion diminish disuse atrophy of knee extensor muscles. Med Sci Sports Exerc2000;32:2035-2039

[4] Bloomfield SA. Changes in musculoskeletal structure and function with prolonged bed rest. Med Sci Sports Exerc1997;29:197-206.

[5] Zanotti E, Felicetti G, Maini M, et al. Peripheral muscle strength training in bed-bound patients with COPD receiving mechanical ventilation: effect of electrical stimulation. Chest 2003;124:292-6

[6] Muscaritoli M, Anker SD, Argilés J, et al. Consensus definition of sarcopenia, cachexia and pre-cachexia: joint document elaborated by Special Interest Groups (SIG) "cachexia-anorexia in chronic wasting diseases" and "nutrition in geriatrics". Clin Nutr2010;29:154-9.

[7] Waters DL, Baumgartner RN, Garry PJ, et al. Advantages of dietary, exercise-related, and therapeutic interventions to prevent and treat sarcopenia in adult patients: an update. Clin Interv Aging 2010;5:259-70

[8] Maffiuletti NA, Gondin J, Place N, Stevens-Lapsley J, Vivodtzev I, Minetto MA. Clinical use of neuromuscular electrical stimulation for neuromuscular rehabilitation: what are we overlooking? Arch Phys Med Rehabil. 2018;99(4):806–12.

[9] Bigland-Ritchie B, Jones DA, Woods JJ. Excitation frequency and muscle fatigue: electrical responses during human voluntary and stimulated contractions. Exp Neurol. 1979;64(2):414–

[10] A systematic review on the validity and reliability of tape measurement method in leg length discrepancy

[11] Validity of serum creatine kinase as a measure of muscle injury produced by lumbar surgery Dinesh Kumbhare 1, William Parkinson, Brett Dunlop

[12] Kim SJ, Fairchild MD, IarkovYarkov A, Abbas JJ, Jung R. Adaptive control of movement for neuromuscular stimulation-assisted therapy in a rodent model. IEEE Trans Biomed Eng. 2009;56(2):452–61.

[13] Effect of Passive Range of Motion Exercise on Hemodynamic Parameters on Mechanically Ventilated Patients Mohamed Mohamed Ibrahim El-dosoky Omar1* , Amal Bakr Abo El-Ata2 , Mona Abed El-Rahman Mohamed2 , Heba Abd El-Reheem Abd El-Reheem

[14] Brower RG. Consequences of bed rest. Crit Care Med 2009;37(10Suppl):S422-8.

[15] .Herridge MS, Cheung AM, Tansey CM, et al. One-year outcomes insurvivors of the acute respiratory distress syndrome. N Engl J Med2003;348:683-93.

[16] Bodine SC, Stitt TN, Gonzalez M, et al. Akt/mTOR pathway is a crucial regulator of skeletal muscle hypertrophy and can prevent muscle atrophy in vivo. Nat Cell Biol 2001;3:1014-9.

[17] Bao W, Yang J, Li M, Chen K, Ma Z, Bai Y, Xu Y. Prevention of muscle atrophy in ICU patients without nerve injury by neuromuscular electrical stimulation: a randomized controlled study. BMC musculoskeletal disorders. 2022 Aug 16;23(1):780.

[18] Babault N, Cometti G, Bernardin M, et al. Effects of electromyosti- mulation training on muscle strength and power of elite rugby players. J Strength Cond Res 2007;21:431-7.