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A Study of Electromyographical Muscle Activation during Garudasana Performance in Adult Male Practitioner's

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Abstract

Purpose: The present study main objective was to assess electromyographical (EMG) activity of the tibialis anterior muscle during the garudasana performance among adult male yoga practitioners.

Methodology: For this purpose, cross-sectional study of eight healthy university-level male yoga participants with a mean age of 20.37 years were conducted by using purposive sampling technique for the present study. EMG data were recorded by using Biolite four-channel system with surface electrodes placed at tibialis anterior muscle site. Further, selected male subjects performed garudasana from 0 second to 30 seconds and the scores of muscle activity of tibialis anterior were recorded (i.e., 0 second, 10 seconds, 20 seconds, and 30 seconds) in micro-volts respectively.

Findings: Descriptive statistics and one-way-anova analysis were applied to determine the variations in muscle activation levels. Moreover, the results of the present study were revealed the highest mean activation at 10 seconds (ie., 34125.66 µV.) in tibialis anterior muscle and also indicating the greater neuromuscular demand during the early postural adjustment phase. But, no statistically significant differences were founded between the different time intervals ($p > 0.05$) which demonstrate consistent muscle activation recruitment once balance was achieved during the garudasana performance.

Conclusion: Hence, the findings of the present study were concluded that tibialis anterior muscle is key stabilizer for maintaining equilibrium in single-leg postures performance upto 30 seconds duration.

Keywords: Yoga, Asana, Garudasana, Electromyographical, and Muscle Activation

Introduction

Yoga has emerged as a widely practiced complementary and alternative therapy with significant applications in medicine, physiotherapy, and sports science. Yoga is known for its physical and perceptual benefits (Cowen & Adams, 2005; Field, 2016; and, Mooventhan & Nivethitha, 2017). Among the numerous postures (asanas), garudasana (Eagle Pose) is a standing balance posture characterized by single-leg support, limb crossing, and moderate demand on postural control. Electromyographic (EMG) studies enhance understanding of neuromuscular coordination during complex postures such as garudasana (Kumar & Charan, 2020 and Sahu et al., 2021). Balance-oriented postures like garudasana require complex neuromuscular engagement to stabilize the trunk and lower limbs during asymmetric positioning, making them suitable candidates for EMG analysis (Fronczek et al., 2024; Kanjirathingal et al., 2021; and, Taylor & Francis, 2023). Surface EMG has increasingly been applied to evaluate muscle activity and recruitment patterns during asana performance, providing objective insights into which muscles are activated and their contribution to posture stabilization, symmetry, and coordinated movement (Devaraju et al., 2019 and Dewan et al., 2023). Previous studies on Garudasana have highlighted symmetrical alignment of the trunk relative to the supporting limb and demonstrated stable center of pressure (CoP) parameters regardless of the supporting side (Fronczek et al., 2024). EMG evaluations, further, suggests that spinal stabilizers, particularly the lumbar erector spinae, play a significant role in maintaining upright posture during this asana (Fronczek et al., 2024). Additionally, postural control and stability insights from athletic and clinical populations highlight the importance of balanced muscle activation (Grabara, 2014; Varambally & Gangadhar, 2016). Beyond spinal stabilization, garudasana requires substantial activation of specific lower and upper limb muscles. The gastrocnemius contributes to postural stability through ankle plantarflexion control, particularly in single-leg stance (Kanjirathingal et al., 2021; Brenneman et al., 2015; and, Rawlings, 2025). The tibialis anterior involves in dorsiflexion and aids in dynamic balance adjustments to prevent forward sway (Okubo et al., 2024; Dewan et al., 2023). The biceps femoris, part of the hamstring group, supports knee flexion and joint stabilization during the crossed-leg position of garudasana (Chopp-Hurley et al., 2018; Dewan et al., 2023). Meanwhile, the biceps brachii assists in maintaining the characteristic arm-crossing position, contributing to upper limb muscle endurance and neuromuscular engagement (Sahu et al., 2021). Yoga's mental health benefits and rehabilitative potential have also been explored (Schmid et al., 2012; Cohen et al., 2011). Yoga and asana found notable journal prominence, global participation, and increasing publication output from 2015 to March 2023 (Sharma et al., 2025). (Om Magazine, 2009 and Art of Living, 2024) exhibits the benefits which are augmented by the pose's dynamic engagement across multiple muscle groups and joints. Furthermore, EMG monitoring of these muscles enables more comprehensive mapping of neuromuscular coordination during Garudasana, where both lower and upper limb muscles interact to sustain balance, symmetry, and posture. EMG-based biomechanical evaluation is critical, as improper recruitment may predispose practitioners to imbalance and musculoskeletal strain. Identification of activation patterns during garudasana can help instructors and clinicians optimize training protocols, improve balance on the non-dominant supporting limb, and normalize excessive muscle tension to minimize injury risk (Chopp-Hurley et al., 2018; Okubo et al., 2024; and, Kelley, 2018). Therefore, EMG analysis of the gastrocnemius, tibialis anterior, biceps femoris, and biceps brachii during garudasana offers valuable insights into postural control, spinal and limb stabilization, and neuromuscular coordination. Such investigations enhance the safety and precision of yoga practice and hold clinical relevance for balance and rehabilitation strategies in populations with neuromuscular limitations.

METHODOLOGY

Table No. 1.1 Overview of the study

Ethical Approval
Approved by Institutional Ethics Committee, Institute of Medical Sciences, BHU.

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Contributors
Eight healthy male university yoga practitioners, (Mean age = 20.37 yrs), Exclusion: injuries/chronic conditions and Informed consent obtained

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Objective
Investigate tibialis anterior activation during Garudasana performance

▼

Study Design
Cross-sectional design

▼

Apparatus
Biolite 4-channel EMG system used Disposable electrodes on tibialis anterior

▼

Electrode Placement
Skin cleaned with 70% alcohol, Electrodes on muscle belly (verified) and secured with adhesive tape

▼

Procedure
Human Performance Lab, BHU, 3 single-session trials and Data from 3rd trial analyzed

▼

MVIC Testing
30 sec. per muscle (initiation, hold, release) and >120 s rest to minimize fatigue

▼

Asana
Participants performed Garudasana

▼

Scoring
Data recorded in micro-volts (µV)

This cross-sectional study was investigated the tibialis anterior muscle activation during Garudasana (Eagle Pose) in eight healthy university male students. For this purpose, approved was granted by the Ethical Committee of IMS, BHU. The data was collected at the human performance lab of Department of Physical Education, BHU. EMG signals were recorded by using a Biolite 4-channel system with standard electrode placement at the muscle site(http://seniam.org/) and MVIC testing of three trials from 0 seconds to 30 seconds at different 4 phases with complete recovery of more than 120 seconds to avoid muscular fatigue between the trials. Further, the selected subjects were performed three single-session trials of the grudasana for 30 seconds respectively. Average score of three trials was recorded in micro-volt (µV) nearest to the 0.001 micro- volt (µV).

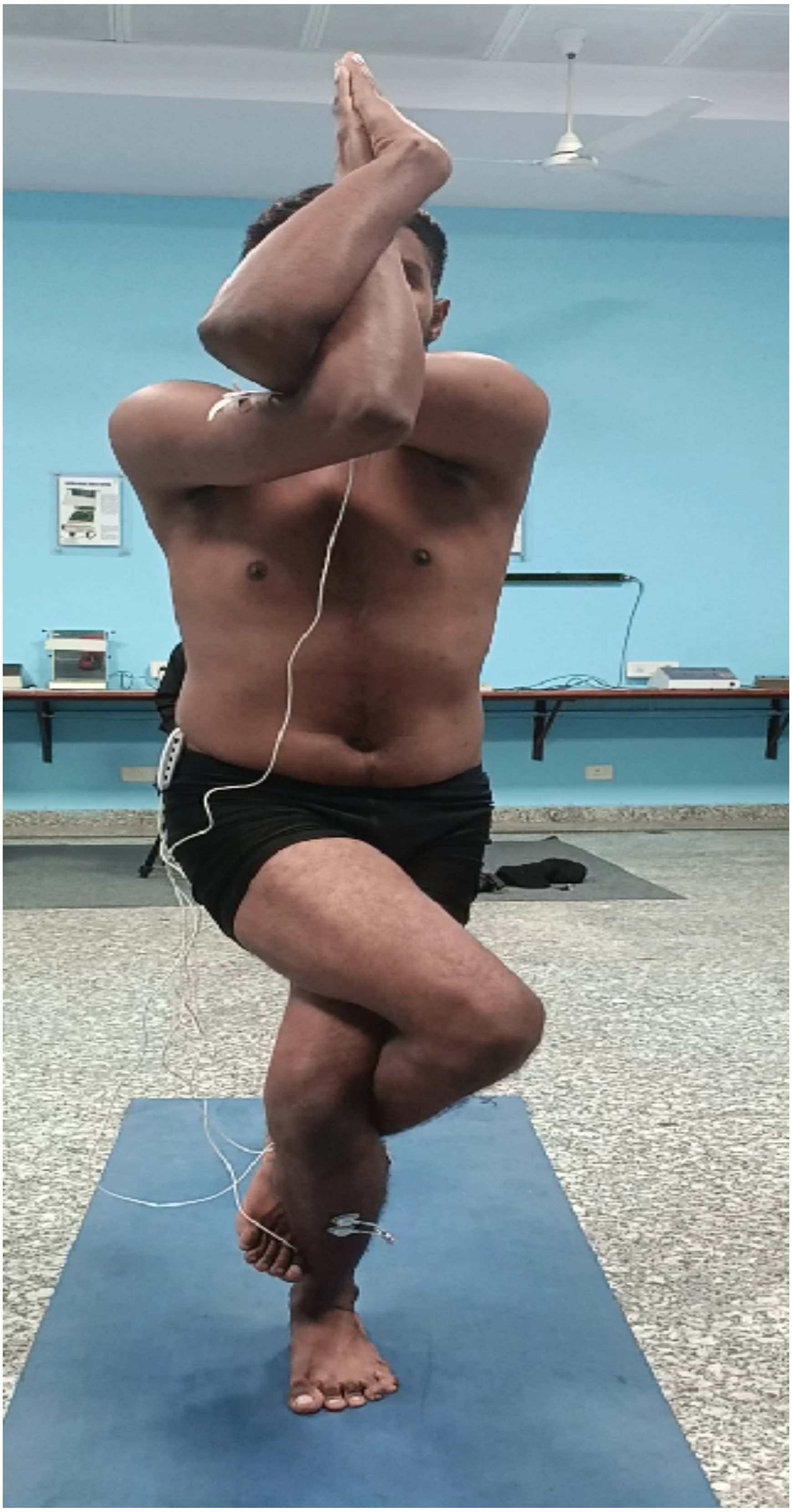

Figure No. 1.1 Anterior view of Garudasana Performance

Findings

Table No. 1.1. Description of Electromyographical Analysis of Tibialis Anterior Muscle Activation in Selected Subjects during Garudasana Performance at Different Intervals of Time in Seconds

Time	N	Mean	Std. Deviation	Std. Error	Minimum	Maximum
0sec.	8	32806.95	29.10	10.28	32771.67	32862.67
10sec.	8	34125.66	3898.12	1378.19	27342.00	41464.33
20sec.	8	33435.75	1286.58	454.87	32409.00	36186.33
30sec.	8	32680.41	437.37	154.63	31670.33	33200.33

Table No. 1.1 indicates the descriptive statistical analysis of the electromyographical (EMG) activity of the tibialis anterior muscle which were recorded in micro-volts at different time intervals (i.e., 0 second, 10 seconds, 20 seconds, and 30 seconds) during Garudasana performance by selected male subjects respectively. Furthur, at the 0-second, the tibialis anterior exhibited a mean EMG activation of 32,806.95 µV with a standard deviation (SD) of 29.10 µV, and readings were ranged from 32,771.67 µV to 32,862.67 µV. The mean EMG value rose sharply to 34,125.66 µV (SD = 3,898.12 µV), with the broadest range recorded in the study at 10 seconds (27,342.00 µV to 41,464.33 µV) which exhibits the significant variation in muscle activation. Moreover, by the 20-second interval, the mean activation slightly was declined to 33,435.75 µV (SD = 1,286.58 µV), with values ranging between 32,409.00 µV and 36,186.33 µV. At 30 seconds, the mean EMG activation was further decreased to 32,680.41 µV (SD = 437.37 µV), with a tighter range from 31,670.33 µV to 33,200.33 µV. Overall, across all 32 observations, the tibialis anterior electromyographical muscle activation analysis was indicated an average EMG activity of 33,262.19 µV with an overall SD of 2,046.80 µV, suggesting moderate fluctuations in activation throughout the performance of garudasana, particularly peaking at the 10-second interval before stabilizing in later stages.

Table No. 1.2. One-way Analysis of Variance (ANOVA) of Electromyographical Analysis of Tibialis Anterior Muscles Activation during Garudasana Performance in Selected Male Subjects

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	10571288.87	3	3523762.95	0.827	0.490
Within Groups	119299881.87	28	4260710.06		
Total	129871170.75	31			

Table No. 1.2 exhibits the findings of the one-way analysis of variance (ANOVA) was analyzed to evaluate the electromyographical (EMG) activity of the tibialis anterior muscle activation during garudasana performance by selected male subjects at different time set intervals. The analysis indicated that between-groups sum of squares was 10,571,288.87 with 3 degrees of freedom (df), resulting the Mean Square was 3,523,762.95. The within-groups sum of squares was 119,299,881.87 with 28 degree of freedom and producing a Mean Square of 4,260,710.06. The Total sum of squares was 129,871,170.75 with 31 degree of freedom. The computed F-value of 0.827 and a significance level (sig. = 0.490) indicates that there were no statistically significant differences in tibialis anterior muscle activation between the observed time intervals during garudasana performance.

Discussion

The present study aimed to investigate the electromyographical (EMG) activity of the tibialis anterior muscle activation during the performance of garudasana among adult male practitioners. The findings of the present study were revealed that the tibialis anterior muscle activation exhibited variable activation levels between the selected time intervals (0, 10, 20, and 30 seconds), with a peak mean activity recorded at the 10-second mark before gradually stabilizing toward the end of the posture. This observed increase in EMG amplitude during the initial holding phase was indicated the higher neuromuscular demand for maintaining balance and ankle stability during single-leg stance. Further, this pattern aligns with findings of Okubo et al. (2024) in which they indicate about increased tibialis anterior muscle activation during yoga-based stabilization tasks due to its crucial role in dorsiflexion control and prevention of anterior sway. Similarly, Dewan et al. (2023) also reports the heightened activation of lower-limb muscles in balance-oriented yoga postures and Fronczek et al. (2024) exhibits the subsequent decline in muscle activity observed after 10 seconds which suggests that practitioners achieve improved postural equilibrium as proprioceptive adjustments stabilize and consistent with the adaptation mechanism. Moreover, the one-way-anova analysis findings were also reported that no statistically significant difference was founded in tibialis anterior muscle activation between the different time intervals ($p > 0.05$) which implying overall stability in muscle recruitment activation once equilibrium is established during posture performance. However, the transient peak at 10 seconds emphasizes the initial load of dynamic balance integration, particularly on the dominant supporting limb. These findings are inconsonance with the findings of Kanjirathingal et al. (2021), highlights about the recruitment of ankle stabilizers, including the tibialis anterior muscle activation during yoga-based balance intervention among individuals with postural instability. Comparable EMG patterns have been identified in other postures involving single-leg support, where tibialis anterior and gastrocnemius muscles act synergistically to maintain balance and alignment (Brenneman et al., 2015; Rawlings, 2025). The absence of significant variance further suggests that trained university-level participants possess adequate neuromuscular adaptation and balance control during Garudasana performance which reflecting efficient coordination in them. EMG evidence of such steady activation mirrors the findings by Devaraju et al. (2019), who noted consistent contraction durations in yoga postures involving static balance control.

Conclusion

The study shows that tibialis anterior activation remains steady throughout three phases of garudasana performance, with peak engagement around the 10-second mark during maximum postural adjustment. The consistent activation pattern indicates efficient neuromuscular control essential for maintaining balance in single-leg postures. Furthur, these findings highlight the tibialis anterior as a key stabilizing muscle. Moreover, this study concluded that the regular garudasana practice can improve proprioceptive awareness, ankle stability, and overall postural control.

Scope: The finding of the present study was recommended that similar studies will be conducted by including among the different time intervals of more than 30seconds, different age groups and different genders respectively.

Contribution: All authors contributed to the design and implementation of the research, to the analysis of the results and to the writing of the manuscript.

References

1. Brenneman, E. C., Kuntz, A. B., Wiebenga, E. G., & Maly, M. R. (2015). A yoga strengthening program designed to minimize the knee adduction moment for women with knee osteoarthritis: a proof-of-principle cohort study. PloS one, 10(9), e0136854.
2. Chopp-Hurley, J. N., Prophet, C., Thistle, B., Pollice, J., & Maly, M. R. (2018). Scapular muscle activity during static yoga postures. journal of orthopaedic & sports physical therapy, 48(6), 504-509.
3. Sharma, D., Dogra, D. K., Sharma, R., & Ali, H. (2025). A systematic literature review on yoga and asanas. *Journal of Bodywork and Movement Therapies, Elsevier. 44(4), 44-47. https://doi.org/10.1016/j.jbmt.2025.05.022*.
4. Devaraju, V., Ramesh, A. B., Alva, K. K., Debur, V. R., & Omkar, S. N. (2019). A mathematical method for electromyography analysis of muscle functions during yogasana. International Journal of Yoga, 12(3), 240-246.
5. Dewan, M., Nijhawan, M., Chhabra, H. S., Shandilya, S., Kumar, P., & Phadke, V. (2023). Electromyographic analysis of trunk and hip muscles during Yoga poses prescribed for treating chronic low back pain. Journal of Bodywork and Movement Therapies, 36, 117-124.
6. Forkuo, G. O. (2022). A systematic survey of conventional and new postural assessment methods. Rev. Pădurilor, 138, 1-34.
7. Fronczek, M., Kopacz, K., Kopacz, Ł., & Padula, G. (2024). The role of objective movement analysis in the control of yoga asanas: A case study. Complementary Medicine Research, 31(2), 201-209.
8. International Journal of Trend in Scientific Research and Development (IJTSRD). (2023). An anatomical exploration of "Garudasana." Retrieved from https://www.ijtsrd.com/papers/ijtsrd33465.pdf
9. Kanjirathingal, J. P., Mullerpatan, R. P., Nehete, G., & Raghuram, N. (2021). Effect of yogasana intervention on standing balance performance among people with diabetic peripheral neuropathy: a pilot study. International journal of yoga, 14(1), 60-70.
10. Kelley, K., Slattery, K., & Apollo, K. (2018). An electromyographic analysis of selected asana in experienced yogic practitioners. Journal of Bodywork and Movement Therapies, 22(1), 152-158.

11. Okubo, Y., Morikami, T., Uebayashi, K., & Motohashi, E. (2024). Characteristics of electromyographic activity during yoga-applied stabilization exercises. Journal of Bodywork and Movement Therapies, 40, 196-202.
12. Om Magazine. (2009). Yoga anatomy: Eagle pose (Garudasana). Retrieved from https://www.ommagazine.com/yoga-anatomy-eagle-pose-garudasana/
13. Rawlings, J. (2025, April 6). The complete guide to Eagle Pose alignment and anatomy. Retrieved from https://jennirawlingsblog.com/blog/the-complete-guide-to-eagle-pose-alignment-and-anatomy
14. Sahu, P., Singh, B. K., & Nirala, N. (2021). Effect of various standing poses of yoga on the musculoskeletal system using EMG. In Computer-aided Design and Diagnosis Methods for Biomedical Applications (pp. 89-112). CRC Press.
15. Sahu, P., Singh, B. K., & Nirala, N. (2021). Effect of various standing poses of yoga on the musculoskeletal system using EMG. In Computer-aided Design and Diagnosis Methods for Biomedical Applications (pp. 89-112). CRC Press.
16. Yoga Journal. (2025, March 24). Eagle pose: How to practice Garudasana. Retrieved from https://www.yogajournal.com/poses/eagle-pose/