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# A Comparative Analysis of the Electromyographic Activity of Selected Upper Limb Muscles Between the Right and Left Sides During the Magyar Skill on the Pommel Horse in Artistic Gymnastics

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## Abstract

The aim of this research is to analyze and compare the electrical activity of selected upper limb muscles between the right and left sides during the performance of the Magyar skill on the pommel horse in artistic gymnastics in order to identify any muscular activity asymmetries among national team athletes. The researcher employed the descriptive analytical method due to its suitability for the nature of the study. The sample consisted of seven (7) gymnasts from the Iraqi national gymnastics team. The mean age was 22 years (±2.381) mean height was 170.571 cm (±5.940) mean weight was 62.286 kg (±5.736) and mean training experience was 11 years (±1.826). Electromyographic (EMG) recordings were taken during the technical execution of the skill using a Noraxon EMG system. The study focused on three primary muscles: anterior deltoid, posterior deltoid and triceps brachii in both the right and left limbs. The results indicated no statistically significant differences between the sides in either peak or average muscle activation values suggesting a well-balanced muscular coordination as a result of effective training programs. The study recommends the use of EMG analysis as a precise diagnostic tool for performance evaluation and training guidance. It also calls for future research on other skills and apparatuses to further explore muscular balance in artistic gymnastics.

**Keywords**: Electromyography (EMG), Pommel Horse, Artistic Gymnastics, Magyar.

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## Introduction

Artistic gymnastics is a complex sport which necessitates substantial muscular balance and coordination when executing advanced maneuvers on the pommel horse. These skills largely require the muscles in the upper limb to enable kinetic co-ordination and stability during performance. As a result, the Magyar skill is one of the most basic circular components in pommel horse routines since performing this trick requires symmetry and stability between the right and left sides to create fluidity and precision.

To analyze the muscular responses during the performance of this skill, we need to accurately measure them with appropriate instruments, since most versatile is electromyography (EMG). EMG is commonly employed to evaluate the muscular electrical activity corresponding to athletic performance in order to characterize neuromuscular coordination or shortcomings. As shown by Farina and Merletti (2004), EMG represents an ideal way to analyze muscle activity during the skill performance. " In a related context, Subasi (2019) found that balanced muscle effort among limbs signifies effective neuromuscular control. Akl et al. (2021) reported a significantly lower injury risk in repetitive movements due to balanced patterns of muscle activation. Additionally, Yadav & Sharma (2025) demonstrated that EMG was capable of identifying minor variations in muscle reaction while performing physical tasks. also stated that the establishment of EMG data-driven training programs can directly improve carrying out technical execution and create varied muscular fatigue (Rodrigues et al., 2023; Abdulhussein et al., 2026).

Thus, this makes it very important to analyze the electromyographic activity of selected upper limb muscles during the performance of a skill, i.e. Magyar, to determine the degree of balance and asymmetries between the right and left sides, which indirectly tells us about coordination in athletes. This analysis offers know-how-derived data that helps coaches train-based programs.

## Methods and Instruments

The researcher used a descriptive–analytical approach, which is relevant to the nature of research because it aims to analyze electromyographic activity on specified upper limb muscles while performing Magyar skill on the pommel horse in artistic gymnastics.

The sample of the study comprised seven (7) athletes representing the Iraqi National gymnastics team, as they were purposely selected due to their high level of technical performance and training amount. The mean age of participants was found to be (22 ± 2.381) years and their ages ranged from 19 to 25 years. Participants had a mean height of (170.571 ± 5.940) cm, mean mass of (62.286 ± 5.736) kg, and mean training age (11 ± 1.826) years.

The experiment was conducted in the gymnastics hall of the College of Physical Education and Sport Sciences, University of Baghdad. Each participant began with a general and specific warm-up lasting 15 minutes, after which they were asked to perform the Magyar skill on the pommel horse.

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A Noraxon EMG system comprised of multiple channels to detect surface muscle electrical activity was used to record the electromyographic activity. After cleaning the skin with alcohol to improve signal quality and reduce electrical impedance, four surface electrodes were placed on the skin. The muscles were recorded bilaterally (left and right sides) as follows:

1. Anterior Deltoid
2. Posterior Deltoid
3. Triceps Brachii

Data were collected during skill execution, and the following variables were extracted from the EMG signals:

- Peak value
- Mean value

The signals were processed using specialized software to convert them into numerical data suitable for statistical analysis.

Statistical analyses were conducted using SPSS software, including:

- Means and standard deviations for descriptive data
- Independent samples t-test to identify differences between the right and left sides

## Results

**Table 1.** *Independent Samples t-test for Differences Between Right and Left Sides in the Magyar Skill for the Investigated Muscles (Peak and Mean Variables)*

| Muscles | Variable | Right Side (Mean) | ± SD | Left Side (Mean) | ± SD | t-value | p-value | Significance |
|---|---|---|---|---|---|---|---|---|
| Anterior | Peak | 1134.857 | 379.773 | 1160.271 | 463.251 | 0.112 | 0.912 | Not sig |
| Deltoid | Mean | 354.700 | 106.312 | 321.114 | 76.737 | 0.678 | 0.511 | Not sig |
| Posterior | Peak | 844.729 | 442.942 | 1311.300 | 742.466 | 1.428 | 0.179 | Not sig |
| Deltoid | Mean | 286.353 | 145.541 | 423.786 | 250.099 | 1.257 | 0.233 | Not sig |
| Triceps | Peak | 1344.014 | 677.240 | 1239.586 | 236.776 | 0.385 | 0.707 | Not sig |
| Brachii | Mean | 478.371 | 129.064 | 516.314 | 101.345 | 0.612 | 0.552 | Not sig |

Degrees of freedom (df) = (7 + 7 − 2 = 12), Significant at (0.05) level if p-value < 0.05.

## Discussion

Electromyographic (EMG) activity analysis is one of the most accurate and in addition objective techniques in assessing efficiency muscle reactions to motor skills execution. This is crucial in sports with high neuromuscular coordination like artistic gymnastics that require striking integration between the upper and lower limbs to achieve balance and precision (Subasi 2019).

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Hence, investigation of potential side-differences in muscle activation during the performance of Magyar skill on pommel horse is needed to identify muscular asymmetries while seeking for optimal technical execution.

No statistically significant (p) difference was found between the right and left side with respect to the EMG activity of investigated muscles both for peak and mean variables at 0.05, as per independent samples t-test results shown in the table above. The muscles investigated were anterior deltoid, posterior deltoid and triceps brachii. The similar response of both extremities in terms of performance during the Magyar skill indicates that muscle groups within each limb show balanced contraction when performing this task, with no asymmetrical neuromuscular responses among players. This suggests:

1. Efficient distribution of effort between both arms.
2. The skill relies on a balanced motor pattern requiring muscular equilibrium on both sides.
3. Similar levels of muscle activation between limbs as a result of continuous skill training (Roberto & Dario, 2016).

Based on the Magyar skill that consists of continuous, circular movements with support from upper limbs, symmetrical balance and stability are required for these positive performance indicators in motor outcomes. The results also confirm the beneficial effects of training programs designed to enhance symmetric muscle control in both limbs, which corresponds with modern-day training paradigms focusing on symmetry and integrated activity within muscle groups required for multi-joint skills (Bompa & Buzzichelli, 2019; Abdulghani et al., 2025).

In addition to the above, the lack of any marked differences between sides in any of the muscles analysed indicates functional efficiency and demonstrates that participants were competent enough in order to not rely on one limb for a skill. It also indicates the efficiency of the selected system in muscle balance and strength bilaterally. This finding highlights the need for bilateral training in gymnastics programs to decrease injury risk due to muscular imbalances and improve motor balance (Behm et al., 2004; Abdulkareem et al., 2025).

We further concluded that EMG should be included as a tool to evaluate performance, due to its sensitivity in identifying slight functional differences that may contribute to the scientific design and prescription of training methods. As a matter of fact, the researcher suggests implementing EMG analysis in regular checks during gymnastics training to help with early detection of muscular imbalances and correcting their course before it provokes performance detriment.

Excessive unilateral muscle activity leading to balance issues may result in technical faults whilst performing (lateral deviation, inadequate control whilst changing direction or difficulty transitioning between skills)—none of which were present in the population sample.

Mohsen (2025) studied a set of pommel horse skills performed by gymnasts, and using EMG analysis found that differences between limbs are often non-significant for high-level athletes that is also in agreement with present study.

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In light of the biomechanic features of the Magyar, this skill demands symmetrical use of both arms during the push-off and circular phases. This requires strength and muscular development to perform effectively, with balance on the equipment (Hassan & Abdulkareem, 2025).

Gymnastics skills that rely on bilateral support require integration between both limbs, which limits large discrepancies in muscle electrical activity—consistent with the current findings (Abuwarda & Gomaa, 2021; Essam & Shaboot, 2023).

Furthermore, Seemann-Sinn et al. (2025) Performance on the pommel horse requires a high degree of muscular balance, and any coordination disturbance among the limbs can result in poor performance efficiency and risk of injury.

## Conclusions

1. This result indicated that the Magyar skill is not directly separated into 2 sides in national teams of players as it is performed with a symmetrical muscular pattern which also means that training programs are successfully leading to muscular harmonious balance to perform this complex skill.
2. This suggests that muscle activation patterns were functional not only with respect to the motor characteristics of different multisystem kinetic but also towards the body stabilization necessary for proper execution of gymnastics technical skills.
3. The findings of this review yielded the important role of bilateral training, which predominantly allows symmetrical muscle-development and less reliance on unilateral movement activity essential for the injury prevention strategies resultant muscular imbalances.
4. These data decrease the diagnostic process of functionally relevant muscle adaptations and detect potential asymmetries at an early stage, underlining that EMG tools should become a part of gymnastics training and evaluation protocols.
5. The researcher's concludes that obtaining a balance between antagonistic muscle pairs is heterogeneous and future studies to develop a better understanding of the muscle balance mechanisms relative to types of skills and apparatus conditions are recommended, but from similar methodologies on various technical skills and devices in gymnastics.

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## Appendices

**Appendix 1.** *Experts and Specialists Consulted to Identify Key Muscles and Skills in Artistic Gymnastics*

| No. | Name | Position |
|---|---|---|
| 1 | Amer Sukran Hamza | Vice President of the Iraqi Gymnastics Federation |
| 2 | Mahmoud Saleh Mahdi | National Team Coach |
| 3 | Mowaffaq Jabbar Abdul Karim | National Team Coach |
| 4 | Saleh Noor Jaafar | International Judge (Yemen) and Certified Gymnastics Coach |
| 5 | Mazen Taha Omar | Certified Gymnastics Coach in the United States |
| 6 | Osama Ahmed Al-Taie | Lecturer at the University of Baghdad, Specialist in Physiology |

**Appendix 2.** *Assistant Work Team*

| No. | Name |
|---|---|
| 1 | Dr. Osama Ahmed Al-Taie |
| 2 | Dr. Yasser Najah |
| 3 | Dr. Huda Hamid |
| 4 | Mr. Mustafa Ahmed |

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**Appendix 3.** *Electromyography (EMG) Device*


**Appendix 4.** *Descriptive Data of the Research Sample*

| No. | Participant | Age (years) | Height (cm) | Weight (kg) | Training Age (years) |
|---|---|---|---|---|---|
| 1 | Omar Abbas | 19 | 178 | 64 | 9 |
| 2 | Hussam Mowaffaq | 23 | 178 | 70 | 12 |
| 3 | Abdullah Jamal | 25 | 171 | 58 | 14 |
| 4 | Mousa Jamal | 21 | 163 | 54 | 10 |
| 5 | Hussein Ali | 19 | 170 | 65 | 9 |
| 6 | Mohammed Issam | 23 | 170 | 67 | 11 |
| 7 | Mohammed Ali | 24 | 164 | 58 | 12 |

**Appendix 5.** *A Sample Performance of a National Team Player in the Pilot Study*

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**Appendix 6.** *A Sample Performance of Selected National Team Players in the Main Experiment*

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