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Acute Effects of Triceps Brachii Self-Myofascial Release on Basketball Shooting Performance: Experimental Research

Triceps Brachii Kasına Uygulanan Kendi Kendine Miyofasyal Gevşemenin Basketbolda Şut Performansı Üzerine Akut Etkileri: Deneysel Araştırma

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ABSTRACT Objective: This study aimed to investigate the acute effects of self-myofascial release (SMR) applied to the triceps brachii with different durations on basketball shooting performance. **Material and Methods:** Twenty basketball players (10 male, 10 female; mean age: 20.6±1.5 years) voluntarily participated to this study. A within-subject repeated-measures design was employed, consisting of a familiarization session and 3 testing protocols: baseline (no SMR), SMR30 (30 seconds×2 sets), and SMR60 (60 seconds×2 sets). Standardized warm-up procedures were followed before each protocol, after which SMR was applied to the dominant triceps brachii using a lacrosse ball. Shooting accuracy was assessed using a 5-zone shooting test, with successful shots recorded and shooting accuracy calculated. Data were analyzed using repeated-measures analysis of variance. **Results:** The results showed no significant differences in successful shots or shooting accuracy among baseline, SMR30, and SMR60 conditions ($p>0.05$). **Conclusion:** These findings indicate that triceps brachii SMR, regardless of application duration, does not acutely affect basketball shooting accuracy. From a practical perspective, SMR may be integrated into warm-up routines without concern for negatively impacting shooting performance; however, it should not be expected to enhance accuracy. Future studies with larger samples, diverse upper extremity muscle groups, and additional performance metrics are recommended to further clarify the role of SMR in basketball-specific skills.

Keywords: Upper extremity; myofascial release; basketball; shooting performance; shooting accuracy

ÖZET Amaç: Bu araştırmada, triceps brachii kasına farklı sürelerde uygulanan kendi kendine miyofasiyal gevşemenin (kMFG) basketbol şut performansı üzerindeki akut etkilerini araştırmayı amaçlamıştır. **Gereç ve Yöntemler:** Araştırmaya 20 basketbol oyuncusu (10 erkek, 10 kadın; ortalama yaş: 20,6±1,5 yıl) gönüllü olarak katılmıştır. Çalışmada, denek içi tekrarlı ölçümler deseni kullanılmış ve bir familarizasyon oturumu ile 3 test protokolü uygulanmıştır: Referans (kMFG yok), kMFG30 (30 sn×2 set) ve kMFG60 (60 sn×2 set). Her protokol öncesinde standart bir ısınma yapılmış, ardından kMFG, dominant triceps brachii kasına lacrosse topu kullanılarak uygulanmıştır. Şut doğruluğu, 5 bölgeden oluşan şut testi ile değerlendirilmiş, başarılı şutlar kaydedilmiş ve şut doğruluğu hesaplanmıştır. Veriler, tekrarlı ölçümlerde varyans analizi ile analiz edilmiştir. **Bulgular:** Sonuçlar, referans, kMFG30 ve kMFG60 koşulları arasında başarılı şut sayısı ve şut doğruluğu açısından anlamlı farklılık bulunmadığını göstermiştir ($p>0,05$). **Sonuç:** Bulgular, uygulama süresinden bağımsız olarak triceps brachii kMFG'nin basketbol şut doğruluğunu akut olarak etkilemediğini ortaya koymaktadır. Pratik açıdan bakıldığında, kMFG ısınma rutinlerine dâhil edilebilir ve şut performansını olumsuz etkilemeden uygulanabilir; ancak doğruluk üzerinde bir artış beklenmemelidir. Daha büyük örneklemler, farklı üst ekstremite kas grupları ve ek performans ölçütleriyle yapılacak çalışmaların, basketbola özgü becerilerde SMR'nin rolünü daha kapsamlı şekilde ortaya koyması önerilmektedir.

Anahtar Kelimeler: Üst ekstremite; miyofasiyal gevşeme; basketbol; şut performansı; şut doğruluğu

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Athletes typically perform a warm-up routine before training or competition to maximize performance and prevent injuries.[1] Warm-up is an important component for optimizing performance before an exercise session.[2] In addition, self-myofascial release (SMR) is also thought to act as a potential warming effect.[3] Short-term SMR sessions before exercise do not appear to affect muscle performance, the greatest effect has been reported to be on flexibility.[4,5] As a result, coaches and researchers strive to identify pre-exercise methods that will provide the most benefit for flexibility and strength development.[6]

One of the key performance indicators that most influences winning and losing in basketball is the players' ability to shoot accurately from different distances, and in 4 different Olympic Games, the average points per game were recorded as 78.7±13.7-80.6±10.2, and shooting accuracy was recorded as 49.0±6.2-51.6±4.0%.[7-9] The main muscle groups of the upper extremity activated during shooting are the forearm (brachialis) and the flexors of the arm and hand (anterior deltoid, biceps, coracobrachialis) during the handling phase, and the extensors of the forearm (triceps) and the pronators (pronator teres) during the shooting finishing phase.[10] A recent study emphasized that the primary muscles involved in basketball shooting are the medial deltoid, longissimus dorsi, triceps, and flexor carpi radialis longus.[11]

SMR is a type of myofascial release that is performed not by a clinician but usually by the individual themselves using a tool.[12] The effects of SMR improve athletic performance by increasing range of motion through changes in tissue quality and neuromuscular function, particularly in movements involving activation such as the stretch-shortening cycle.[6] Furthermore, SMR can stimulate mechanoreceptors and cause physiological changes in the myofascia.[13] SMR, frequently used by athletes during warm-up or cool-down phases of training, is an intervention applied to increase mobility in the muscular fascia using foam rollers, massage rollers, or various tools (massage sticks, massage guns, lacrosse balls, tennis balls, etc.) for soft tissue.[14-17] It produces significant effects on range of motion and strength in athletes.[18,19] Like foam rollers, lacrosse balls are also useful tools for myofascial release and are used more often on relatively smaller muscle groups or small areas such as the soles of the feet, upper extremity muscles, back muscles, and pectoralis majör.[20-23]

There are a limited number of studies focusing on the effects of different SMR intervention durations.[17,24,25] It is stated that SMR performance is negatively affected after 120 seconds.[26] It has been emphasized that longer durations of SMR appear to be more beneficial in terms of perfusion for exercise professionals designing warm-up and cool-down routines.[24] However, another study involving 1- and 5-minute SMR applications emphasized that longer-term SMR increases range of motion, but that power output is critical in exercises following SMR, and therefore, prolonged SMR sessions lasting 5 minutes should be avoided.[17] In the aforementioned studies focusing on SMR application duration, it is observed that the upper extremity was not included as the application region. In the literature, most studies involving applications such as SMR focus on lower extremity muscle groups.[14,27-33] Additionally, according to the authors' knowledge, previous studies have not examined the effect of SMR applied to the upper extremity on shooting performance, a basketball-specific skill. It is critically important to understand the extent to which athletes' sport-specific performance is influenced when they use SMR as a warm-up strategy prior to demonstrating their main performance. Therefore, the purpose of this study is to determine the acute effect of SMR with different application durations on the triceps brachii muscle of basketball players on shooting accuracy. This study hypothesizes that SMR applied to the triceps brachii muscle for different durations will not change shooting accuracy.

MATERIAL AND METHODS

PARTICIPANTS

A total of 20 basketball players, including 10 male and 10 female, volunteered to participate in the study (Table 1). Inclusion criteria are (a) being a licensed basketball player, (b) participating in basketball training at least 5 days per week, and (c) actively competing in official matches. Exclusion criteria are: (a)

TABLE 1: Characteristics of participants

	X̄±SD	minimum	maximum	95% CI
Age (year)	20.6±1.5	19.0	24.0	19.9-21.3
Training experience (year)	10.6±2.4	6.0	14.0	9.5-11.7
Body height (cm)	180.4±11.1	159.6	198.3	175.2-185.6
Body mass (kg)	76.5±13.4	51.0	99.0	70.2-82.8

SD: Standard deviation; CI: Confidence interval

having suffered a musculoskeletal injury within the last 3 months, (b) having performed strenuous exercise within the last 48 hours, (c) having any current muscle pain or myofascial restriction. Participants were informed verbally and in writing about the protocols and measurements prior to the study, and their written consent was obtained. This study was conducted in accordance with the Declaration of Helsinki and was approved by the Gazi University Ethics Committee (Research Code No: 2024-1063; meeting date: 09.07.2024; meeting number: 12).

STUDY DESIGN

Repeated measurements were conducted using a within-subject design in this study. The experimental procedures were completed within a total of 10 days, following a familiarization session and 3 measurement protocols at 72-hour intervals in Gazi University Yasar Sevim Sports Hall. After the participants were identified in the first session, they were informed about the research protocol in writing and verbally, and then the athletes' characteristics were determined. Familiarization was conducted to ensure that the athletes understood the SMR protocols on the measurement days and applied them with the correct form. Application elements such as position, region, and rolling speed were supervised and monitored by the researchers for the athletes. In the second session, athletes performed shooting accuracy measurement following the warm-up; in the third session, they performed warm-up, followed by the 30 sec×2 sets SMR protocol (SMR30) and shooting accuracy measurement; and in the fourth session, they performed warm-up, followed by the 60 sec×2 sets SMR protocol (SMR60) and shooting accuracy measurement. In the baseline protocol, the shooting test was completed after a 1-minute rest interval following the warm-up, whereas in the SMR protocols, the shooting test was completed after a 1-minute rest interval following the warm-up, the SMR intervention, and an additional 1-minute rest interval (Figure 1).

Experimental Procedures

Basketball players performed a standardized warm-up protocol before each session, consisting of 3 minutes of line drills, 5 minutes of dynamic mobilization exercises, and 2 minutes of static stretching (total duration: 10 minutes). After the warm-up, a 1-minute rest period was given in all protocols. After the warm-up, participants completed 3 protocols: The baseline protocol (without SMR), the SMR30 proto-

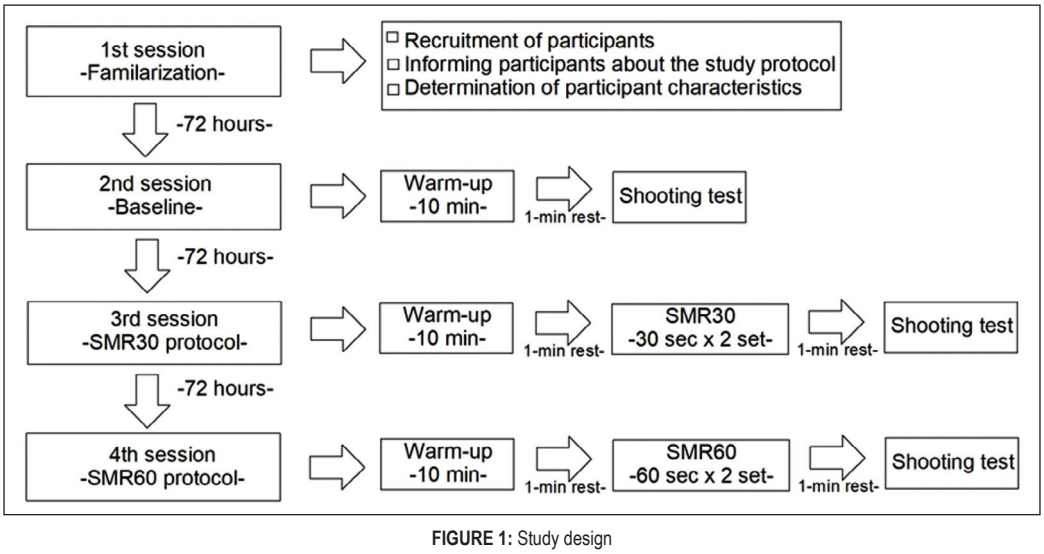


FIGURE 1: Study design
SMR: Self-myofascial release

col, and the SMR60 protocol. The SMR intervention was applied to the dominant triceps brachii muscle using a lacrosse ball (PROTONE Fitness Lacrosse Ball, PROTONE, China). In SMR protocols, participants positioned themselves standing with knees flexed on a table 120 cm high, with a lacrosse ball fixed on the table, to increase pressure using their body weight without sitting (Figure 2a). The dominant arm to receive SMR was positioned in full extension on the lacrosse ball. In the triceps brachii muscle, the lacrosse ball was rolled back and forth between the olecranon and the posterosuperior part of the shoulder on the medial and long heads (Figure 2b, 2c, 2d). Each SMR protocol consisted of 2 sets performed at a speed of 30 bpm (SMR30: 30 sec×set, SMR60: 60 sec×2 set). A 30 sec interval was given between sets in the SMR30 protocol, and a 60 sec interval in the SMR60 protocol. A shooting test was administered following a 1-minute interval after the SMR protocols.

A 5-zone shooting test was used to measure shooting accuracy (Figure 3). In this test, players started from zone 1 as shown in Figure 3 and performed 5 consecutive shot attempts in each of zones 2-3-4-5 in sequence, with no time limit. After each shot, 2 researchers provided the players with ball feeds from under the basket. After 5 shots were attempted in each zone, the successful shots were counted and recorded as "number" of successful shots. The total number of successful shots was obtained by adding up the number of successful shots in each zone. Shooting accuracy was obtained by dividing the number of successful shots by the total number of shots and was presented as a "percentage".

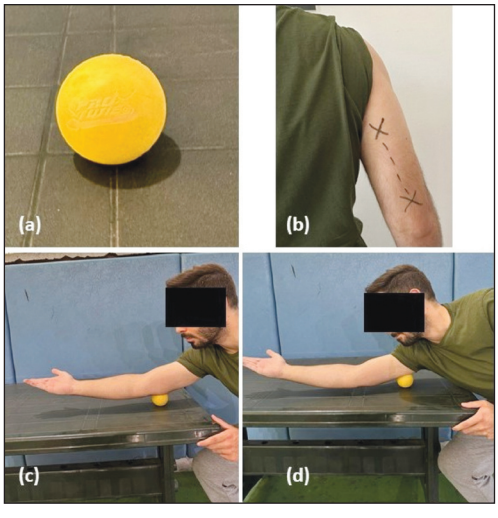


FIGURE 2: SMR protocol applied to the triceps brachii muscle using a lacrosse ball. a) Lacrosse ball; b) SMR application region; c) starting point of the SMR intervention on the triceps brachii muscle; d) ending point of the SMR intervention on the triceps brachii muscle.
SMR: Self-myofascial release

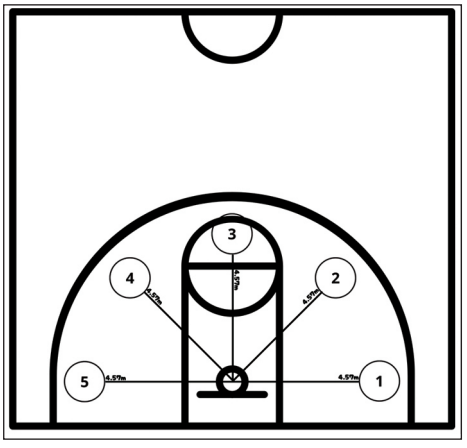


FIGURE 3: Five-zone shooting test experimental protocol

DATA ANALYSES

The data were presented as mean and standard deviation. The normality of data distribution was tested using the Shapiro-Wilk test. Repeated-measures analysis of variance was used to compare the effects of SMR interventions on shooting accuracy between protocols. When data were not normally distributed, the Friedman repeated measures analysis of variance on ranks was applied. Statistical analyses were performed using SigmaPlot 11.0 (from Systat Software, Inc., San Jose, California, USA), and the level of statistical significance was set at 0.05.

RESULTS

In basketball players, SMR applied to the triceps brachii with two different durations showed no significant effect on the number of successful shots or shooting accuracy compared to the baseline protocol ($p=0.168$) (Figure 4).

In the shooting accuracy test, no significant differences were found between the protocols in successful shots or shooting accuracy in any zone ($p>0.05$) (Table 2).

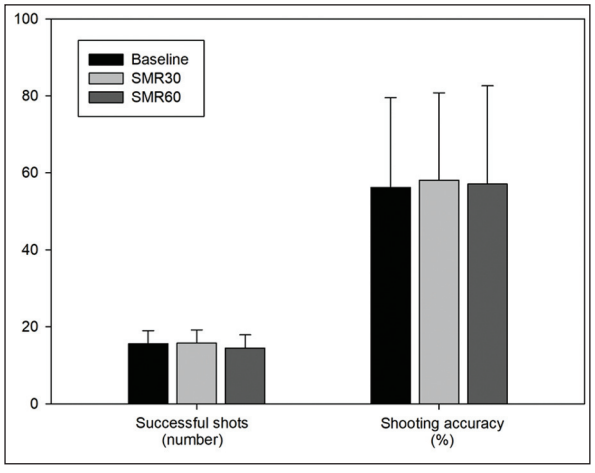


FIGURE 4: The acute effect of SMR protocols applied to the triceps brachii muscle on the number of successful shots and shooting accuracy in basketball players
SMR: Self-myofascial release

TABLE 2: Successful shots and shooting accuracy of basketball players after baseline, SMR30 and SMR60 protocols

		Baseline	SMR30	SMR60	p value
Zone 1	SS	3.1±1.2	3.2±1.1	2.8±1.1	0.399
	SA	62.9±24.7	64.8±22.7	56.2±21.6	0.399
Zone 2	SS	3.2±1.3	3.5±1.1	2.9±1.2	0.231
	SA	64.8±25.2	69.5±22.5	57.1±23.1	0.231
Zone 3	SS	3.1±1.1	3.1±1.0	2.9±1.1	0.385
	SA	62.9±22.2	61.9±19.9	57.1±21.2	0.385
Zone 4	SS	3.3±1.0	3.0±1.2	3.1±0.9	0.673
	SA	65.7±19.1	61.0±24.9	61.9±18.9	0.673
Zone 5	SS	2.8±1.2	2.9±1.1	2.9±1.3	0.965
	SA	56.2±23.3	58.1±22.7	57.1±25.5	0.865

Data are presented as mean±standard deviation. SS: Successful shots; SA: Shooting accuracy; SMR: Self-myofascial release. Baseline: without SMR. SMR30 protocol: 30 sec×2 sets of triceps brachii SMR. SMR60 protocol: 60 sec×2 sets of triceps brachii SMR. p indicates significance between protocols.

DISCUSSION

This current study aimed to determine the acute effect of SMR with different application durations on the triceps brachii muscle of basketball players on shooting accuracy. Our main finding was that SMR with different durations applied to the triceps brachii muscle did not significantly affect shooting accuracy in basketball players. Therefore, our hypothesis that SMR with different durations applied to the triceps brachii muscle would not alter shooting accuracy was confirmed.

The researchers applied SMR intervention durations through continuous rolling performed for varying lengths of time.[3,32] Some studies, however, have approached the intervention in defined sets.[24,34] There is no consensus on how many times of the application are required to maximize its beneficial effects.[15] However, in a study examining the effects of different intervention durations (60-90-120 sec) on knee extension fatigue, the baseline protocol produced statistically significantly greater fatigue resistance compared to 90 sec and 120 sec of foam rolling (p=0.001).[35] Moreover, it was observed that volumes longer than 90 sec impaired the ability to sustain force production. However, another study reported that SMR longer than 120 sec negatively affected performance.[26] Moreover, some researchers have recommended performing foam rolling for 90-120 sec to see the optimal effect of SMR. Therefore, it is evident that there is no consensus in previous studies regarding the duration of SMR application. In our study, a total SMR duration of 60 sec was applied in the SMR30 protocol and 120 sec in the SMR60 protocol. Our main criterion was that, in real-world training or competition warm-ups, athletes do not perform SMR for longer durations. In a study focusing entirely on the effects of different application durations, foam roller (FR) was applied as 60 sec×2 sets and 180 sec×2 sets without any prior practical session. The results showed that the longer FR duration significantly increased local blood flow (Δ +9.7%) and significantly decreased tissue stiffness (Δ -1.9%).[24] Another study emphasized that after 1 and 5-minute of SMR application, longer-term SMR increases range of motion, but in situations where power output is critical, long-term SMR such as 5 minutes should be avoided.[17] On the contrary, in healthy adult males, 3- and 5-minute SMR did not produce a significant difference in quadriceps femoris isokinetic peak torque, total work, and power compared to the placebo group.[25] Additionally, it has been reported that recovery speed after exercise is significantly better following a rolling exercise lasting at least 120 sec. Our findings reveal that SMR lasting a total of 60-120 sec during the warm-up phase before training or competition does not affect shooting accuracy in basketball, specifically for the triceps brachii, a primary muscle involved in shooting.

This study undoubtedly has some limitations. The first of these is the sample size. Future studies need to validate the findings with a larger number of participants. Furthermore, our study focused on the SMR effect applied to the triceps brachii muscle, which plays a critical role in shooting performance in basketball. Future studies should determine the effect of SMR applied to different regions on shooting accuracy, a skill specific to basketball. Additionally, the effect of SMR application on the triceps brachii was only investigated in terms of shooting accuracy. Furthermore, the effect of this application on parameters such as upper extremity range of motion, muscle tone, and muscle strength could also be investigated. The lack of randomization in the SMR intervention may have created a prior learning effect. This constitutes another limitation of the study. Finally, in SMR protocols, the SMR pressure force is at a level that does not cause pain or discomfort in athletes and is as much pressure as possible with the athletes' own body weight. The only control was that the researchers monitored the athletes to ensure they performed SMR correctly.

CONCLUSION

The aim of this current study was to determine the acute effect of SMR applied to the triceps brachii muscle with different application durations on shooting accuracy in basketball players. Our findings indicate that SMR applied to the triceps brachii muscle with different durations does not change shooting accuracy in basketball players. From a practical standpoint, the application of SMR to the triceps brachii prior to training or competition may be used without concern for impairing shooting accuracy, yet it should not be expected to provide performance enhancement in this context. Future research with larger samples, different upper extremity muscle groups, and additional performance parameters is warranted to provide a more comprehensive understanding of SMR's role in basketball-specific performance.

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Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: *Halil Can Demir, Çağdaş Özgür Cengizel, Elif Cengizel;* ***Design:*** *Halil Can Demir, Çağdaş Özgür Cengizel, Elif Cengizel;* ***Control/Supervision:*** *Çağdaş Özgür Cengizel, Elif Cengizel;* ***Data Collection and/or Processing:*** *Halil Can Demir, Çağdaş Özgür Cengizel, Elif Cengizel;* ***Analysis and/or Interpretation:*** *Halil Can Demir, Çağdaş Özgür Cengizel, Elif Cengizel;* ***Literature Review:*** *Halil Can Demir, Çağdaş Özgür Cengizel, Elif Cengizel;* ***Writing the Article:*** *Halil Can Demir, Çağdaş Özgür Cengizel, Elif Cengizel;* ***Critical Review:*** *Çağdaş Özgür Cengizel, Elif Cengizel;* ***References and Fundings:*** *Halil Can Demir, Çağdaş Özgür Cengizel, Elif Cengizel.*

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