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Immediate effect of shorter duration dynamic stretching on peak hamstrings and quadriceps torque and functional H:Q ratio in football players

Rupali Shevalkar and Dolly Patel

Abstract
There are mixed literature review on effect of dynamic stretching on peak quadriceps and hamstring torque as well functional H/Q ratio. Long duration dynamic stretching proved to decrease the muscle torque hence effect of shorter duration dynamic stretching protocol was studied in football players. Eighteen amature football players, both males and females between age group of 18-25, playing for atleast 2 years were selected. Pre and Post 5 minutes dynamic hamstring and qudriceps stretching, peak muscle torque and functional H/Q ratio was evaluated using HUMAC NORM isokinetic system. Data was statistically analysed using Graph Pad instat 3.10 version. The result showed peak quadriceps and hamstring torque improved and H/Q ratio was decreased significantly post stretching.

Keywords: Dynamic stretching, peak torque, H/Q, footballers

Introduction

Hamstring strains are the most common injuries in football resulting in 12% of all injuries observed over a period [1]. A muscular imbalance of the hamstrings and quadriceps is reported to be a factor which can be attributed to hamstring strains [1]. These strains typically occur during the eccentric phase of muscle contraction. During running, the hamstring muscles become active in the last third of the swing phase undergoing eccentric contraction to decelerate knee extention and oppose the activity of the quadriceps [2]. It provides joint stability and acts as a natural safety mechanism [3]. The increase in antagonistic activation acts as a braking mechanism which also reduces excessive tension on ACL [1].

At ground contact, the hamstrings switch from maximal eccentric to concentric activity and develop the greatest force of any lower extremity muscle. During kicking, the hamstrings are lengthened across both the hip and knee joints [2]. Thus the hamstring muscles are subjected to high forces during both open and closed kinetic chain activities making them vulnerable to injury [2]. Moreover, poor flexibility, inadequate strength and insufficient stretching are other factors associated with hamstring injuries [4, 5]. Therefore, stretching has been recommended as a method for the treatment and prevention of hamstring strains.

Force producing capabilities and relative muscle cross-sectional area is greater of quadriceps compared to hamstrings. Along with its different muscular architecture, quadriceps have a longer range of motion [4]. Thus, flexibility of quadriceps is of importance to improve on-field performance.

As strength imbalances have been associated with the risk of injury, hamstrings to quadriceps ratio (H:Q) has been widely used by sports clinicians as a mean of predicting injury [2, 6, 7]. It is calculated from the ratio of peak/average torque of the eccentrically contracting hamstrings to concentrically contracting quadriceps during knee extension (Yeung *et al*. 2009). Hamstrings and quadriceps flexibility will have an impact on torque, leading to subsequent changes in H:Q ratio. This disproportional hamstrings to quadriceps strength ratio may be inversely related to the risk of lower extremity injuries [6-8]. As the H:Q ratio decreases, the risk of lower extremity injuries may increase [4]. This is effective at discriminating individuals at risk of hamstring injuries.

Pre-athletic event stretching has thus been recommended with the goal of improving a joint range of motion to achieve optimal performance, reduces stiffness and possibly decrease injury

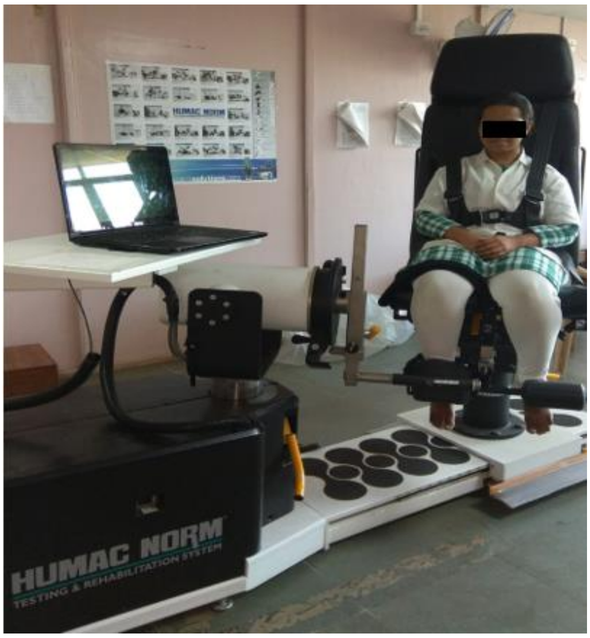
Risk [9, 10]. However, recent evidence has indicated that bout of static stretching may cause transient decrease in isometric and dynamic muscle strength due to a phenomenon known as 'stretching induced force deficit' [11-13]. Thus static stretching of any duration should be avoided when even small decreases in performance are undesirable. Literature quotes mixed reviews for the effect of dynamic stretching on peak torque. Dynamic stretching has been majorly known to increase the peak torque [14, 15] or have no effect [16]. As against this, study done by Pablo B. Costa concluded that dynamic stretching reduced concentric and eccentric hamstring strength as well as conventional and functional H:Q ratios. As longer duration dynamic stretching reduced peak torque, we are aiming to find the impact of shorter duration dynamic stretching on peak torque production and functional H:Q ratios.

Methods and Materials

Permission was taken from the Institutional Review Board. Eighteen intercollege football players within the age group 18-25 with more than 2 years of experience were included. However, any traumatic (eg. fractures of spine, limbs, ACL injury), pathological (pott's spine) or inflammatory conditions (eg. rheumatoid arthritis, ankylosing spondylitis) of musculoskeletal system, metabolic disorders eg. diabetes mellitus, neurological conditions eg. Stroke, Cognitive problems, Post-operative conditions eg. reconstructions of ACL were excluded. All the subjects participating in the study were informed verbally and in writing about the aim of the study, procedure of the study and a written consent was taken.

The peak quadriceps and hamstring torque was measured using HUMAC NORM 2015 isokinetic system.

1. The subjects were informed prior about the procedure before testing. They were acknowledged about concentric and eccentric movements, and the same were performed by them during the procedure. It was also explained to the subjects that the test speed of dynamometer is pre-adjusted and that the resistance would change proportional to the force applied by them.
2. Movements were demonstrated to the subjects as how they should push and pull the arm of the device, and that they should exert maximum effort during pushing and pulling.
3. The joint was placed in the most appropriate position for ideal testing. The backrest angle of the chair of the dynamometer was adjusted to 85° and the subject seated on the chair.
4. The rotational axis of the dynamometer shaft was aligned with the rotational axis of the knee joint (lateral femoral condyle). The knee adaptor of the dynamometer was attached to the extremity, in which the measurements were performed, 3 cm proximal to the dorsal surface of the foot. For stabilization, the belts were tightened across the pelvis, chest and the other knee joint.
5. Firstly, three warm-up trials were performed at the angular velocity of 60°/s. Following a resting period of one minute was given, five repeated tests were performed in order to measure the peak torque values during knee concentric and eccentric extension.
6. Following a resting period of one minute, three repeated warm-up trials at the angular velocity of 180°/s were performed. Then, following a resting period of one minute, five repeated tests were carried out in order to measure the peak torque values and total work performed during knee concentric and eccentric extension.



Picture 1: Isokinetic testing of peak hamstrings and quadriceps torque

Peak Hamstring and Quadriceps torque

Pre and post intervention peak hamstring and quadriceps torque at the speed of 60°/s and 180°/s were evaluated using HUMAC NORM 2015 isokinetic system.

Functional h: q ratio

Functional H/Q ratio was calculated using HUMAC NORM 2015 isokinetic system as follow:

$$\text{Functional H/Q ratio} = \frac{\text{Maximal hamstrings eccentric peak torque}}{\text{Maximal quadriceps concentric peak torque}}$$

Stretching protocol

The stretching protocol consisted of 5 minutes of both hamstring and quadriceps dynamic stretching. Two sets of four dynamic stretching exercises designed to stretch hamstrings and quadriceps. The exercises were performed with each set lasting for 15 repititions with 15 seconds rest periods between sets. Two exercises targeted hamstrings and two targeted quadriceps.

For Quadriceps: For the first quadriceps stretch, from a standing position, the subject flexed the dominant knee such that the heel would move toward the buttocks and then the leg was turned back (Picture 2). For the second quadriceps stretch, the subject flexed the dominant thigh and leg and extended the dominant leg backward (Picture 3). Once completed, the subject brought the leg back to starting position.

For Hamstrings: The first hamstring stretching exercise involved an exaggerated hip extension of the non-dominant leg while flexing the trunk at the hip and waist until both hands approached dominant foot (Picture 4). Once completed, the subject returned to the starting position and repeated the stretch. The second hamstring stretching exercise was performed whiled the subject flexed the dominant thigh while maintaining an extended leg such that the dominant toes were raised as high as possible (Picture 5). The dominant thigh was then extended back to the starting position. The players were then given a rest period of 5 minutes.

Picture 2: Quadriceps Strech1

Picture 3: Quadriceps Stretch2

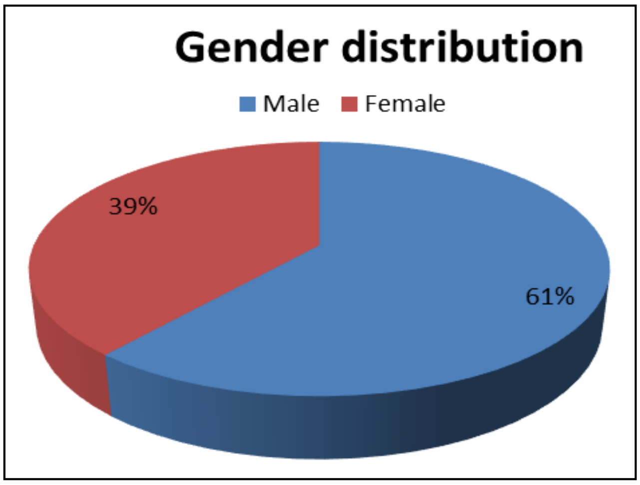
Picture 4: Hamstring Stretch1

Picture 5: Hamstring Stretch2

Results

Table 1: Gender distribution in football players

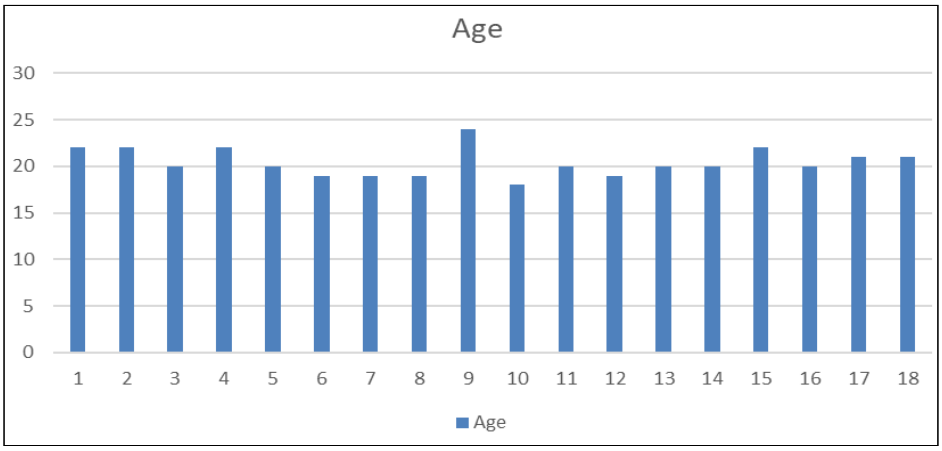
Gender Distribution	No. of Players
Male	11
Female	7



Graph 1: Gender distribution in football players

Table 2: Age distribution in football players

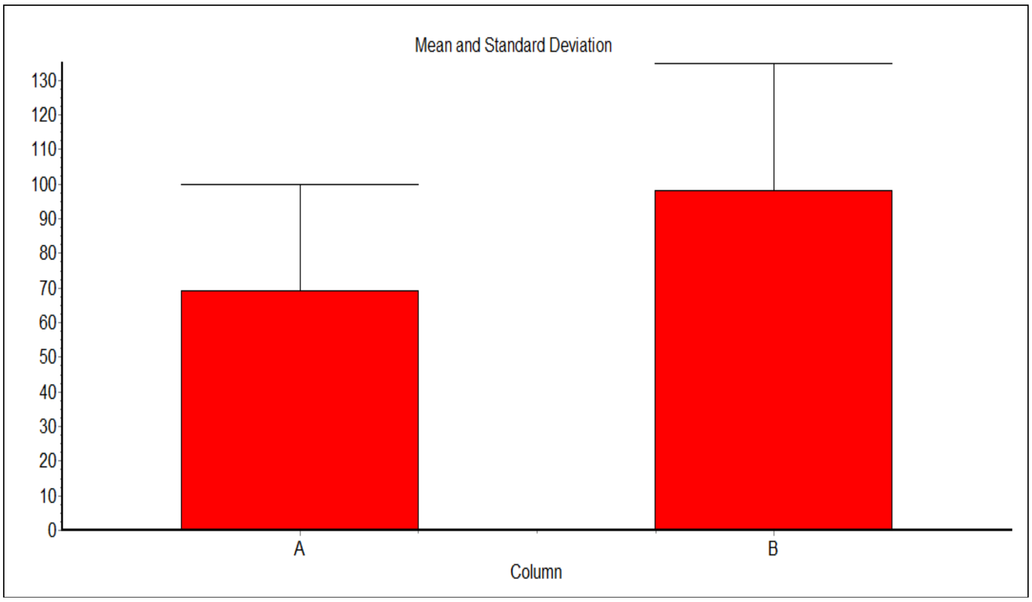
No of participants	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Age	22	22	20	22	20	19	18	18	24	18	20	19	20	20	22	20	21	21



Graph 2: Age distribution in football players

Table 3: Concentric quadriceps peak torque at 60°/s

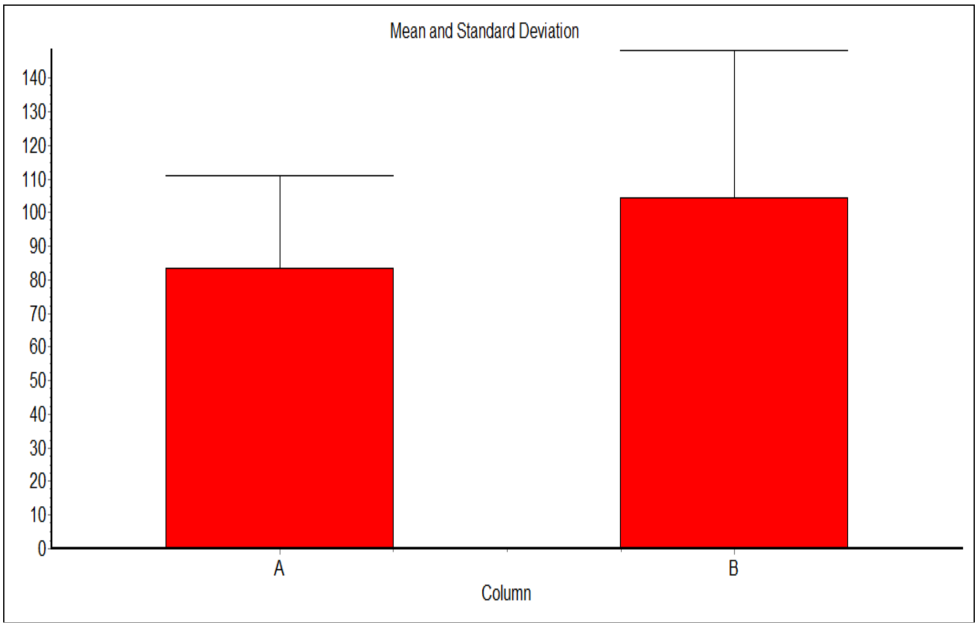
Parameters	PRE	POST
Mean	69.333	98.056
SD	+ 30.611	+ 36.758
t value	5.820	
P value	<0.0001 considered very significant	



Graph 3: Concentric quadriceps peak torque at 60°/s

Table 4: Eccentric quadriceps peak torque at 60°/s

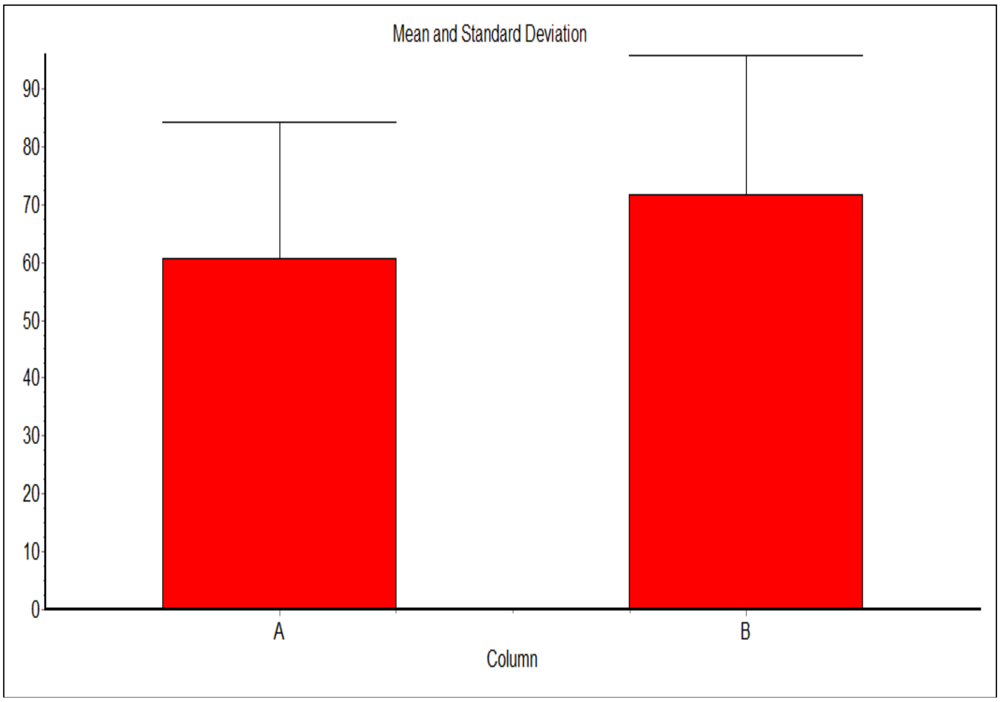
Parameters	PRE	POST
Mean	83.500	104.44
SD	+ 27.579	+ 43.884
t value	2.693	
P value	0.0154 considered very significant.	



Graph 4: Eccentric quadriceps peak torque at 60°/s

Table 5: Concentric Hamstring peak torque at 60°/s

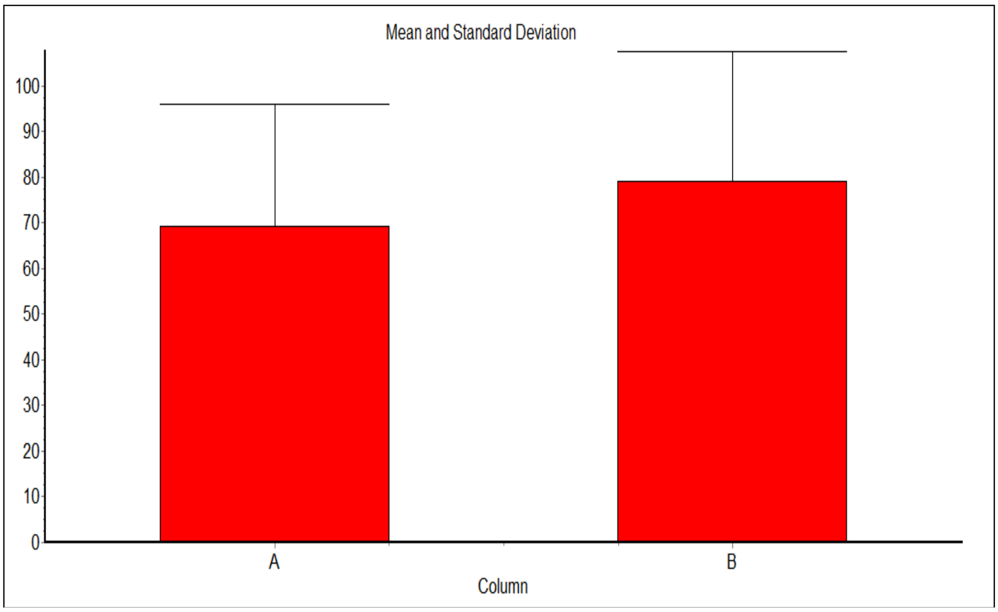
Parameters	PRE	POST
Mean	60.556	71.611
SD	+ 23.645	+ 24.130
t value	3.507	
P value	0.0027 considered very significant	



Graph 5: Concentric Hamstring peak torque at 60°/s

Table 6: Eccentric Hamstring peak torque at 60°/s

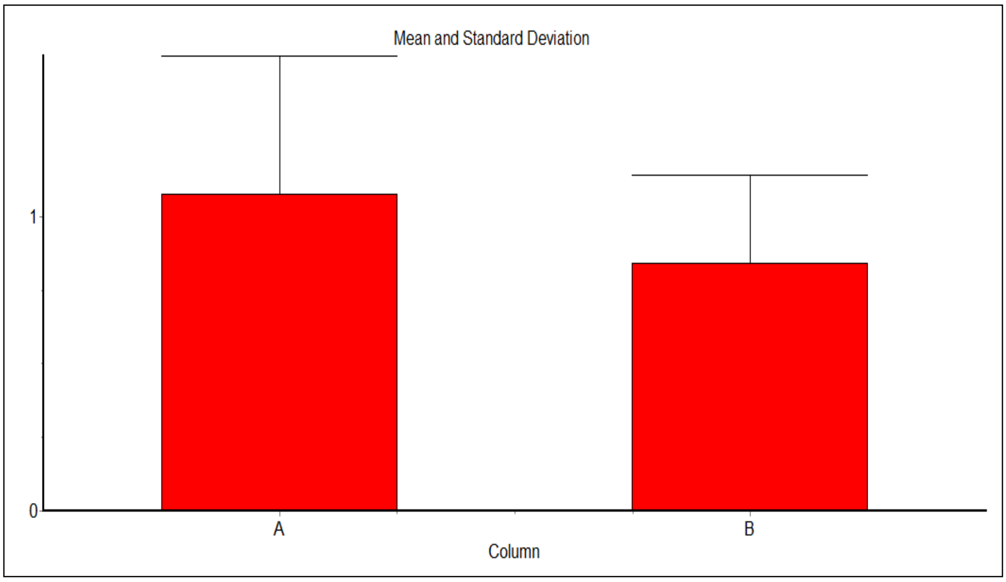
Parameters	PRE	POST
Mean	69.167	79.278
SD	+ 26.803	+ 28.305
t value	3.257	
P value	0.0046 considered very significant	



Graph 6: Eccentric Hamstring peak torque at 60°/s

Table 7: Functional H:Q ratio at 60°/s

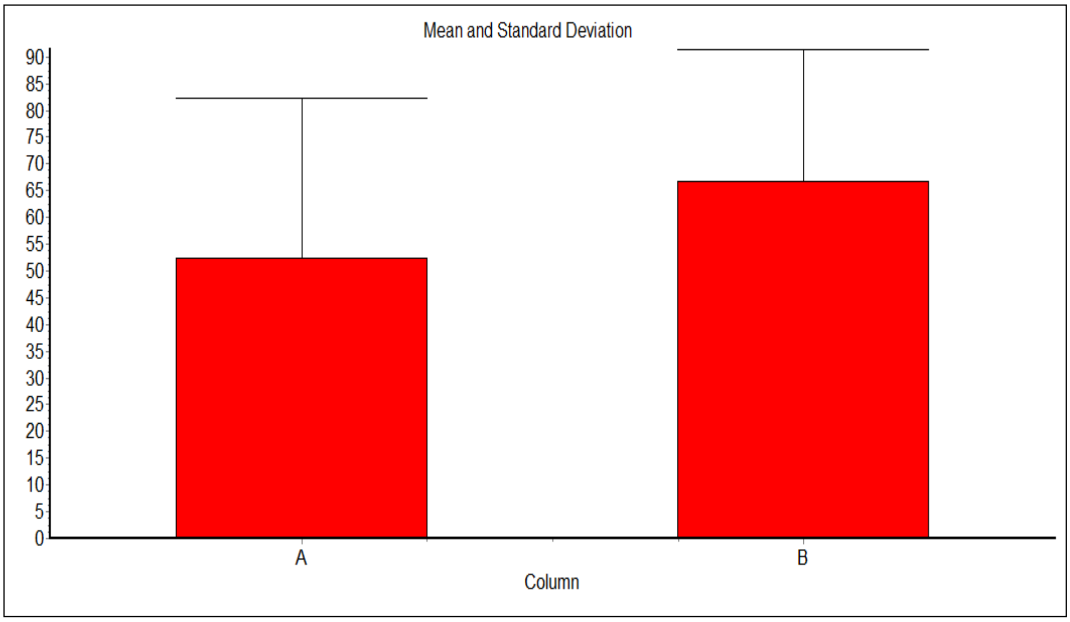
Parameters	PRE	POST
Mean	1.077	0.8411
SD	+ 0.4709	+ 0.3012
t value	2.725	
P value	0.0144 considered very significant	



Graph 7: Functional H:Q ratio at 60°/s

Table 8: Concentric quadriceps peak torque at 180°/s

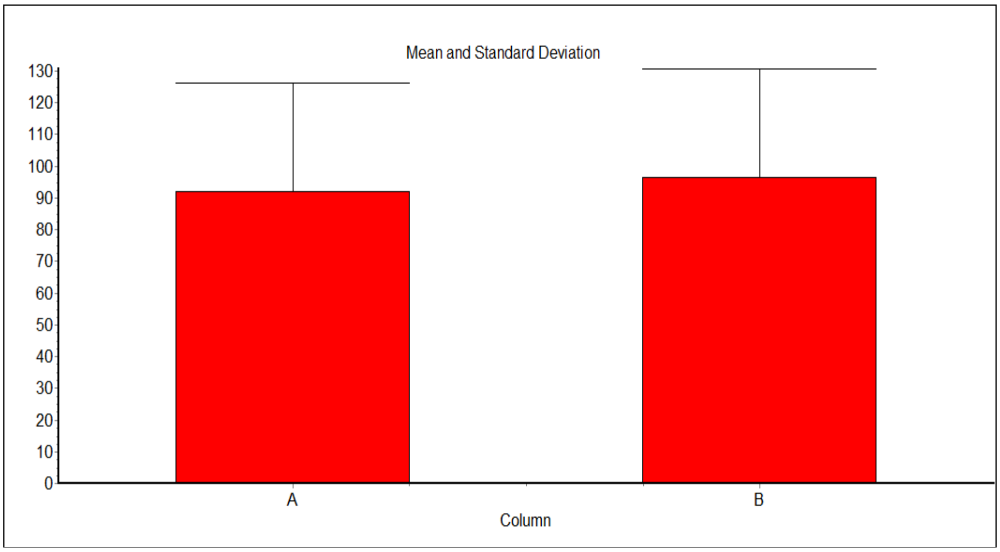
Parameters	PRE	POST
Mean	52.500	66.722
SD	+ 29.762	+ 24.657
P value	0.0005 considered extremely significant	



Graph 8: Concentric quadriceps peak torque at 180°/s

Table 9: Eccentric quadriceps peak torque at 180°/s

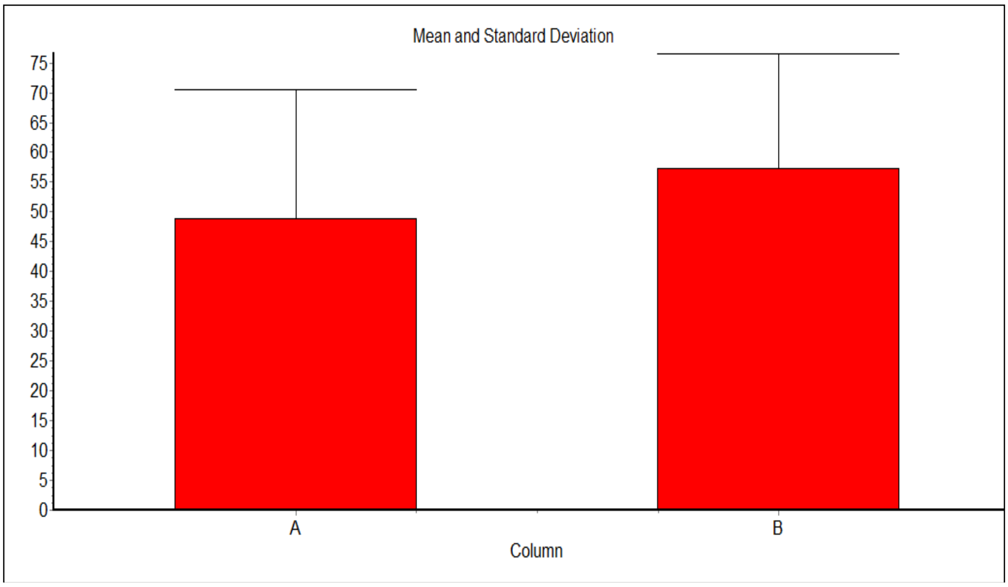
Parameters	PRE	POST
Mean	91.944	96.556
SD	+ 34.144	+ 34.135
t value	1.091	
P value	0.2907 considered not significant	



Graph 9: Eccentric quadriceps peak torque at 180°/s

Table 10: Concentric hamstring peak torque at 180°/s

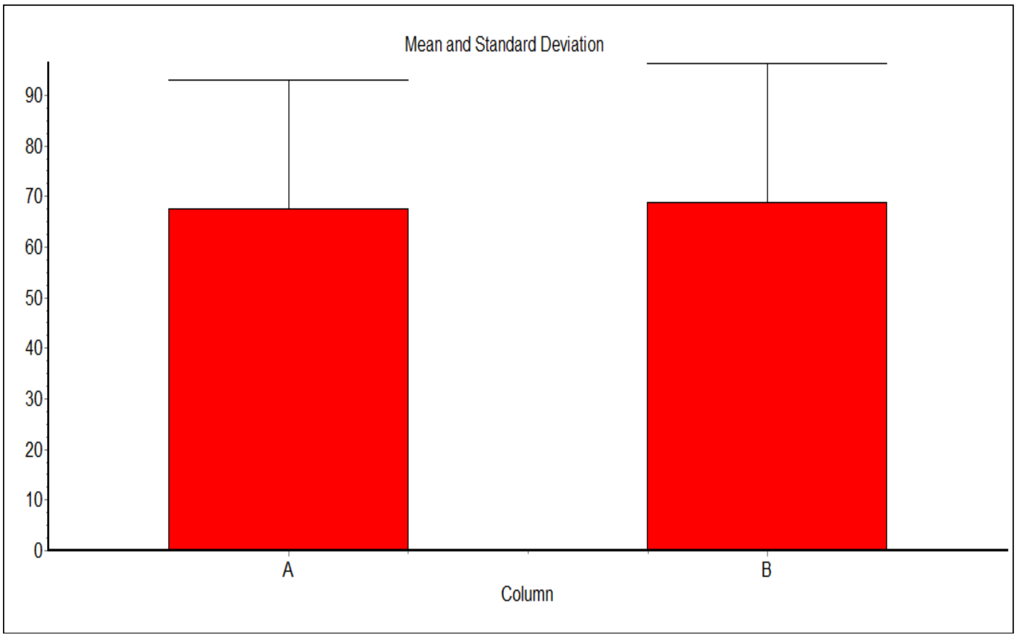
Parameters	PRE	POST
Mean	48.889	57.333
SD	+ 21.657	+ 19.186
t value	2.996	
P value	0.0081 considered very significant	



Graph 10: Concentric hamstring peak torque at 180°/s

Table 11: Eccentric hamstring peak torque at 180°/s

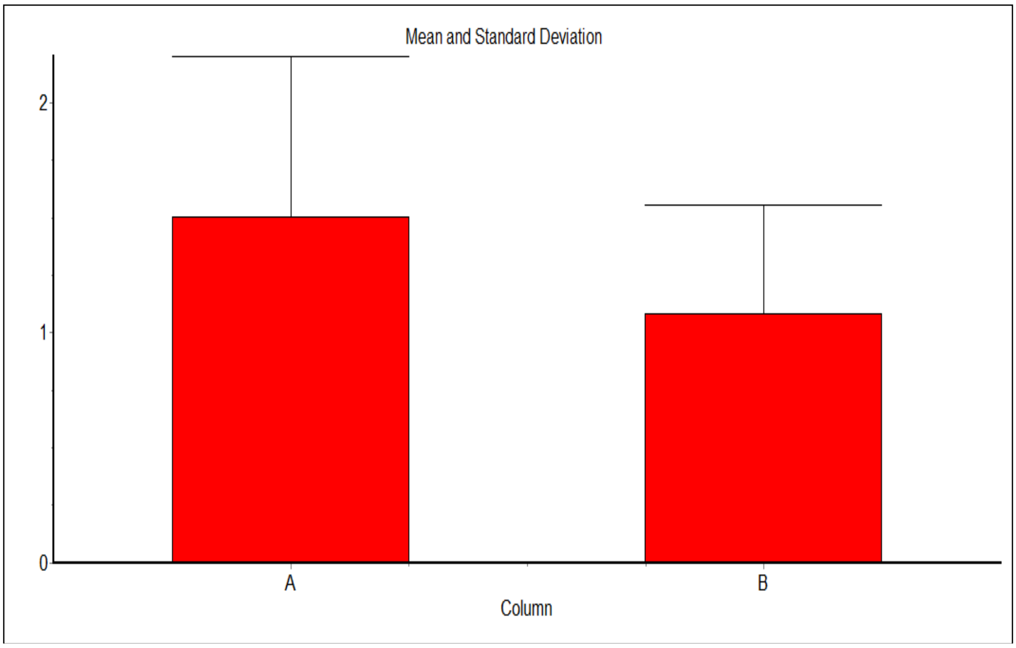
Parameters	PRE	POST
Mean	67.500	68.944
SD	+ 25.406	+ 27.355
t value	0.6320	
P value	0.5358 considered not significant	



Graph 11: Eccentric hamstring peak torque at 180°/s

Table 12: Functional H:Q ratio at 180°/s

Parameters	PRE	POST
Mean	1.507	1.085
SD	+ 0.6950	+ 0.4712
t value	4.260	
P value	0.0005 considered extremely significant	



Graph 12: Functional H:Q ratio at 180°/s

Discussion

The study was conducted in an urban set-up on 18 young inter-college football players between the age group of 18 to 25 years (20.3+ 1.6). Out of 18 subjects, 11 were male and 7 were female.

This study was conducted to assess the immediate effect of short duration dynamic stretching on peak hamstrings and quadriceps torque as well as functional H:Q ratio.The results of the study revealed that dynamic stretching caused immediate increase in peak torque of concentric and eccentric hamstrings at both 60°/s (p =0.0027, p=<0.0001) and 180°/s (p =0.0081, p=0.0005). Also, peak quadriceps torque both concentric and eccentric improved significantly at 60°/s (p=0.0046, p=0.0154) and 180°/s (p=0.5358, p=0.2907). The significant increase in strength is probably as there is postactivation potentiation which is due to voluntary contractions of the antagonist. This can cause improvement in muscular performance after previous contraction as a result of muscular contractile history [4]. One more probable reason for increase in strength could be elevation of muscular temperature [15].

Although this study was the first to examine the acute effects of shorter duration dynamic stretching on peak torque and functional H:Q ratio,our study was not consistent with previous investigations where dynamic stretching showed decrease in peak torque or had no effect at all [14, 16]. Pablo. B. Costa revealed that dynamic stretching decreased concentric and eccentric hamstring peak torque as well as conventional and functional H:Q ratio. In this study, a single muscle group was dynamically stretched for 4 sets; each for 30secs. The decrease in peak torque was attributed to decreases in musculotendinous stiffness and subsequent increases in electromechanical delay similar to those found with static stretching [4]. Sekir *et al*. however reported increases in concentric and eccentric hamstring as well as quadriceps peak torque after dynamic stretching which is attributed to traditional warm-up effect

The knee hamstrings to quadriceps ratio has been considered a useful measure in detecting lower extremity muscle imbalances that could predispose the young athlete to injuries such as hamstring muscle strain, ACL injuries and overuse syndromes [2, 6, 7]. Hence it is important to address in injury prevention program. Traditionally, the H:Q ratio is calculated by dividing the maximal concentric leg flexor peak torque by the maximal concentric leg extensor peak torque, which is regarded as the conventional H:Q ratio that indicates a basic strength comparison between the opposing groups [17]. However, during athletic activities, the hamstrings function in an eccentric manner to resist,control and oppose the powerful contraction of quadriceps during leg extension that takes place during running/kicking [2, 18]. Thus, functional H:Q ratio which is calculated as it measures the ratio of eccentrically contracting hamstrings to concentrically contracting quadriceps is suggestive more of the functional difference in strength of hamstrings and quadriceps [18, 19] It is thus representative of knee stabilization during leg extension.

The results of our study revealed that there was significant reduction in functional H:Q ratio immediately after dynamic stretching at both 60°/s and 180°/s (p=0.014, p= 0.0005). This is consistent with previous investigations. ----- As both hamstrings and quadriceps were dynamically stretched, there was increase in peak torque of both the muscles. As there was increased torque in both the groups, the ratio reduced significantly. This can thus increase the probability of on field injuries. Hence, further investigations could assess the effect of hamstring-only stretching and its effect on H:Q ratio. prevent

Conclusion

The short duration dynamic stretching of both quadriceps and hamstring improved peak torque significantly at the speed of 60°/s and 180°/s. As this protocol improved peak torque, it can be used as a traditional warm up for improvising performance. This can help prevent hamstring injuries.But functional H/Q ratio decreased significantly which might increase the risk of injury. Hence, there is need to study either different duration stretching protocol for both the muscle group or stretching only hamstring group of muscles. The limitation of the study was that long term effect of the stretching could not be assessed.

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