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Sport Specific Muscle Imbalance in Roller Skaters-An Observational Study

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Abstract
Background: *Roller skating is one of the famous skating category pursued as both, a recreational activity as well as a full time profession all over the world. The sport specific posture that the roller-skaters assume throughout the training and practice time is known to be the predisposing factor for muscle imbalance in them.*
Objective: *The primary objective of this study was to find out whether there were any muscular imbalances prevailing in the roller skating population due to the specific posture they attain while engaged in their respective sport activity. The secondary objective was to check the co-relation between the muscle strengths of the dominant side vs the non-dominant side.*
Methodology: *100 roller skaters (n=100) were taken for the study. The muscle strengths of the lower limb and the trunk muscles were measured. The muscle strengths on the dominant side were compared with the non-dominant side to find out correlation between the two.*
Result: *No muscle imbalance was seen between the dominant side vs the non-dominant side($p>0.05$). But a statistically significant correlation($r=0.7$-0.8) was seen in muscle strengths between the left and right side of the body for all muscles except the Ankle plantar flexors which showed poor correlation ($r=0.36$)*
Conclusion: *No sport specific muscle imbalance is seen in roller skaters. There is a correlation between the muscle strength of dominant side and the non dominant side of the body in roller skaters.*
Keywords: *Skating,Roller skaters, Muscle imbalance.*

INTRODUCTION

Skating is one of the popular games which nowadays is gaining more of a professional rather than recreational importance. It is very famous in western countries but at the same time its growing popularity in India cannot be denied. As far as India is considered, the variant of skating which includes the roller skates is gaining popularity There are basically three varieties of roller skates- quad roller skates, inline or blade skates and tri skates. Nowadays, research is been going and ideas are being applied on the basic skating model in order to improve the performance of the skaters. Out of these, in India the quad roller skates are most popular. Competitive figure skaters spend 2-4 hours per day in on-ice training plus 1-3 hours off-ice training for up to 11 months

of the year.[8,9] It is a sport activity wherein high intensity, co-ordinated movements are required along with the additional task of maintaining the posture. The body is subjected to constantly changing postural reactions. As the entire upper limb and lower limb muscles are ultimately challenged to maintain a proper well balanced posture on a constantly-moving, linearly directed 2 point,3 point or 4 point base of support; the entire musculature of the body participates in it depending upon the phase of the motion. Thus, skating is a result of multiple postural reflexes acting in coordination under neuromuscular influence.

Inkelis and Stanley H.MD Et.al studied the prevelance of injuries in roller skaters below 16 years of age. It was observed that 74% injuries were sustained due to various factors like speed, strength and muscle balance.Another study by Wonjae Lee & Songhyun Lee Et.al also established the balance asymmetry in track speed skaters.A study was conducted by Katsushi Akahane and Teiji Kimura Et al to find out the correlation between the leg muscle strength and balance in elite and non-elite speed skaters. The study concluded by defining an ultimate necessity to improve the lower limb musculature strength in speed skaters to improve balance and performance. Another study was carried out by Daehee Lee and Sangyoung Lee Et al to see the effect of knee and ankle stability on muscle activity. The study ultimately concluded that postural stability depends on the efficacy of lower limb joints and muscle stability. David G.Behm and Michael J.Wahl Et al studied the relationship between skating speed and selected performance measures. They found out that the muscle performance increased with speed in ice hockey players.Catherine Mary Hesford and Stewart J.Laing Et al conducted a study to find out the asymmetry of quadriceps muscle oxygenation during elite short-track speed skating

For each and every simple as well as complex physiological action, two muscle groups are the front line participants. The Agonists or the prime movers are the muscle group or individual muscle which is responsible for the initiation of any particular action. For eg. during normal elbow flexion, the action is primarily performed by the Biceps brachialis muscle. So, as far as elbow flexion is concerned, the biceps is the Agonist. Thus, Agonists are the main muscle group responsible for initiation of any movement. this contractile force exerted by the agonists during particular activity needs to be counteracted by another force which needs to be acted in exactly opposite direction as that of the agonists muscles. This counter force is needed to provide stability and to maintain the equilibrium of a stable posture during any activity.

There is another muscle group which acts as a counterpart for the agonists. They are called as Antagonists. Their ultimate function is to maintain the stability of movement by generating counter-balancing forces as that of the agonists. e.g. during Elbow-flexion, the flexor movement of the biceps brachialis muscle is counteracted by the triceps muscle. Thus, Triceps is the Agonist muscle in Elbow-flexion. Besides these two muscle groups, there is one more muscle group which supplements the work of agonists and antagonists. They are called as Synergist muscles.

In normal individuals, the agonists and antagonists act in co-ordination while performing Activities of daily living. But studies have shown that specific postural-deviations lead to disturbed biomechanics of muscles and related intra and extra-articular structures which in turn may lead to imbalance in distribution of muscle-load and their overall performance.

Studies also suggest that about 50% of injuries are traumatic and remaining 50% are due to overuse mechanism.[10]Out of the overall injuries sustained by skaters, 74% of those are attributed to factors like speed, strength of muscles and balance[1]. Balance asymmetry was noted in skaters which also suggests of muscle strength imbalance[2]. Studies have proved that acute injuries are very common in female skaters as compared to their male counterparts.

In skating a forward leaning posture is adopted in order to reduce air resistance and knee extensor strength may be a necessary and indispensable muscular strength characteristic for maintaining the skating posture.[3] The purpose of this study is to find out whether muscle imbalance persists between the agonist and antagonist muscle groups in roller skaters as a result of the Sport-Related posture maintained by them on field.

METHODOLOGY

Ethical clearance was obtained from the institute's ethical committee. All subjects who are roller skaters were screened for inclusion and exclusion criteria. The participants were informed about the aims and procedure of the study. Interested subjects signed the written consent, to be considered for the study. Participants were asse-ssed for muscle strength first by dynamometer.

The lower limb muscle strength was assessed. Twelve muscles were assessed for strength. Subject was lying supine or prone depending on the muscle which was to be assessed. Followed by this, the core muscles were assessed for endurance. Standard testing for trunk extensors and flexors were carried out to serve the purpose. For trunk extension testing procedures, the subjects was asked to lie prone. The lower body was fixed to the plinth by the clinician. The upper body was off the plinth. Subjects were asked to hold their upper body off the end of the table by pushing with their extended arms on a chair directly below them. The subjects were asked to maintain the horizontal position as long as possible once the testing will start. At the initiation of the test, the upper limbs was lifted off the chair and crossed over the chest with the hand resting on the opposite shoulder. A stopwatch was used to time from the instant when the upper limbs were lifted off the chair and crossed over the chest as described above until the subject got visually deviated from the horizontal plane. Standard testing for trunk flexors was performed according to previously published method.[11] Subjects were positioned supine, with both hips and knees flexed to 90 degrees, trunk inclined at 60 degrees resting on a prefabricated wedge.[12] Subjects were asked to cross their arms across the chest, placing their hands on opposite shoulders, in a manner comfortable to them.[12] The wedge was moved back by 10 cm.[12] the timing was started once the wedge was slided back till the subject established visual contact with the wedge.[12]

OUTCOME MEASURES

- HAND HELD DYNAMOMETER

The strain-gauge based isometric Hand Dynamometer can be used to measure muscle strength. Different muscles were checked for strength. The subject is asked to hold the dynamometer and strength is checked in kilograms which has scale from 0-100 .' 0 'means no strength and '100' is maximum strength.

- MODIFIED MCGILL's CORE ENDURANCE TESTING

Standard testing for trunk extensors and flexors will be carried out to serve the purpose. For trunk extension testing procedures, the subjects will be asked to lie prone. The lower body will be fixed to the plinth by the clinician. The upper body will be off the plinth. Subjects will be asked to hold their upper body off the end of the table by pushing with their extended arms on a chair directly below them. The subjects will be asked to maintain the horizontal position as long as possible once the testing will start. At the initiation of the test, the upper limbs will be lifted off the chair and crossed over the chest with the hand resting on the opposite shoulder. A stopwatch will be used to time from the instant when the upper limbs will be lifted off the chair and crossed over the chest as described above until the subject will get visually deviated from the horizontal plane. Standard testing for trunk flexors will be performed according to previously published method.[11] Subjects will be positioned supine, with both hips and knees flexed to 90 degrees, trunk inclined at 60 degrees resting on a prefabricated wedge.

Subjects will be asked to cross their arms across the chest, placing their hands on opposite shoulders, in a manner comfortable to them. The wedge will be moved back by 10 cm. the timing will be start once the wedge is slided back till the subject establishes visual contact with the wedge.

RESULTS

Table: Comparison of Trunk Flexors and Trunk Extensors with respect to mean hold time (in sec) in core muscle strength by independent t test

Trunk	Mean	SD	SE	t-value	P-value
Trunk Flexors	17.87	1.86	0.19	6.1046	0.0001*
Trunk Extensors	15.93	2.58	0.26		

*p<0.05

Figure: Comparison of Trunk Flexors and Trunk Extensors with respect to mean hold time (in sec) in core muscle strength

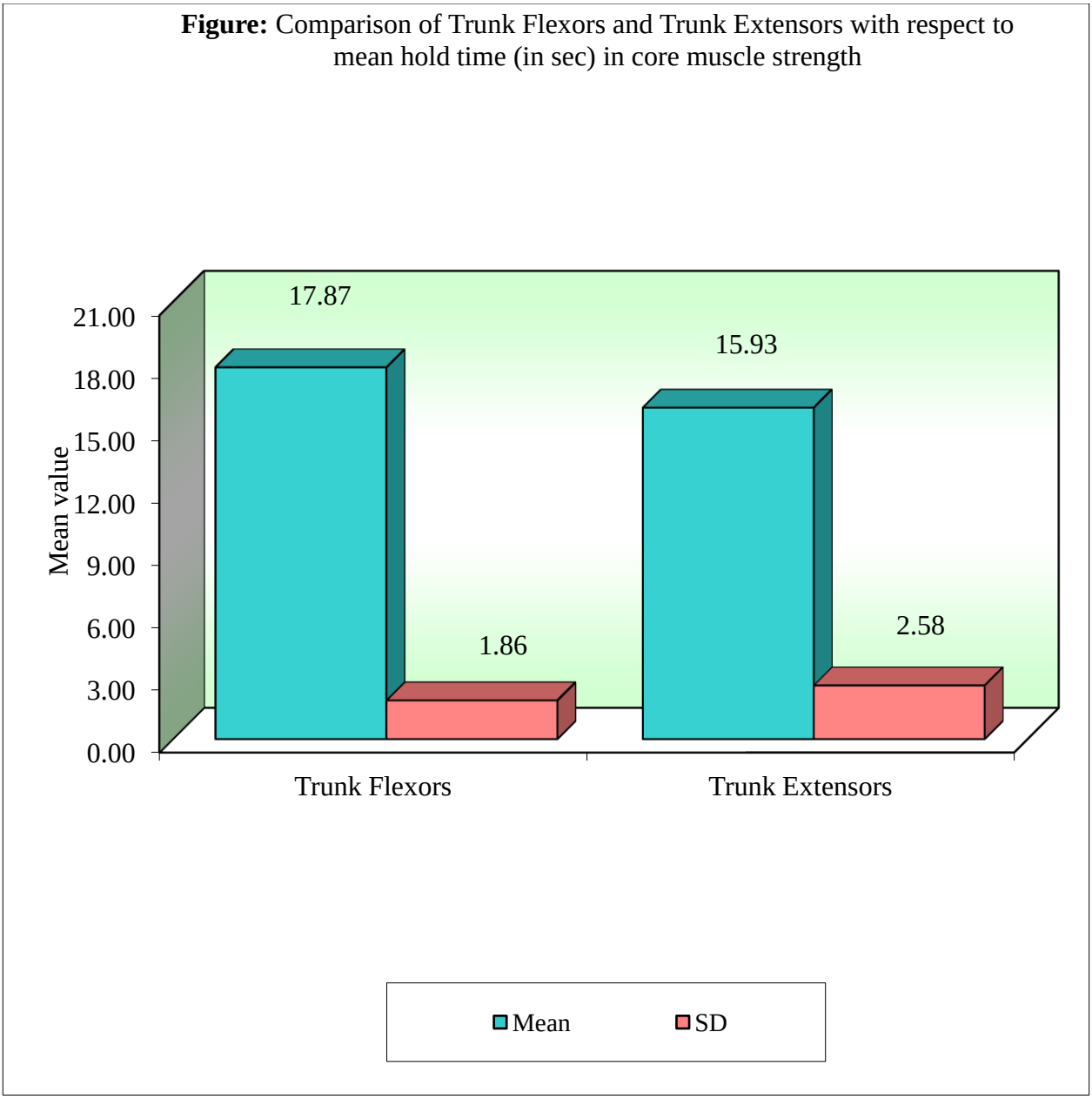

Table: Correlation coefficient between right and sides Muscle strength (Kg) scores by Karl Pearson's correlation coefficient method

	Variables	Correlation coefficient between right Muscle strength (Kg) scores		
		r-value	t-value	p-value
Left side	Hip Flexors	0.8219	14.2827	0.0001*
	Hip Extensors	0.8369	15.1372	0.0001*
	Hip Internal Rotators	0.8257	14.4897	0.0001*
	Hip External Rotators	0.7656	11.7830	0.0001*
	Hip Adductors	0.7225	10.3441	0.0001*
	Hip Abductors	0.7893	12.7248	0.0001*
	Knee Flexors	0.8739	17.7988	0.0001*
	Knee Extensors	0.8899	19.3115	0.0001*
	Ankle Plantar Flexors	0.3686	3.9250	0.0002*
	Ankle Dorsiflexors	0.8663	17.1704	0.0001*
	Ankle Inverters	0.8580	16.5341	0.0001*
	Ankle Everters	0.8308	14.7796	0.0001*

*p<0.05

Table: Correlation coefficient between Trunk Flexors and Trunk Extensors mean Hold Time (in sec) by Karl Pearson's correlation coefficient method

Variables	Correlation coefficient between Trunk Extensors scores		
	r-value	t-value	p-value
Trunk Flexors	0.5942	7.3132	0.0001*

*p<0.05'

The statistical analysis was carried by using SPSS 21 software. Comparision of muscle strengths was done between left vs right side. There was no significant change seen between the muscle strengths.(p>0.05). Trunk flexors and extensor muscles were compared. A significant difference (p<0.05) was seen in muscle strengths of the trunk flexors(mean=17.87,SD=1.86) and trunk extensors (mean=15.93,SD=2.58). Although there was no significant muscle imbalance seen, but a high correlation(r) was seen between muscles of the left vs the right side. Hip flexors(r=0.82), Hip extensors(r=0.83),Hip adductors(r=0.72),Hip abductors(r=0.78), Hip internal rotators(r=0.82), Hip external rotators (r=0.76),Knee flexors(r=0.87), knee extensors (r=0.88), ankle dorsiflexors(r=0.86), invertors (r=0.85) and evertors(r=0.83).

DISCUSSION

The primary objective of this study was to find out whether there were any muscular imbalances prevailing in the roller skating population due to the specific posture they attain while engaged in their respective sport activity. The secondary objective was to check the co-relation between the muscle strengths of the dominant side vs the non-dominant side. Inkelis and Stanley H.MD Et.al studied the prevelance of injuries in roller skaters below 16 years of age. It was observed that 74% injuries were sustained due to various factors like speed, strength and muscle balance. Another study by Wonjae Lee & Songhyun Lee Et.al also established the balance asymmetry in track speed skaters. A study was conducted by Katsushi Akahane and Teiji Kimura Et al to find out the correlation between the leg muscle strength and balance in elite and non-elite speed skaters. The study concluded by defining an ultimate necessity to improve the lower limb musculature strength in

speed skaters to improve balance and performance.

Another study was carried out by Daehee Lee and Sangyoung Lee Et al to see the effect of knee and ankle stability on muscle activity. The study ultimately concluded that postural stability depends on the efficacy of lower limb joints and muscle stability. David G.Behm and Michael J.Wahl Et al studied the relationship between skating speed and selected performance measures. They found out that the muscle performance increased with speed in ice hockey players.

Catherine Mary Hesford and Stewart J.Laing Et al conducted a study to find out the asymmetry of quadriceps muscle oxygenation during elite short-track speed skating.

Comparision of muscle strengths was done between left vs right side. There was no significant change seen between the muscle strengths.($p>0.05$). Trunk flexors and extensor muscles were compared by using the Modified Mcgill's endurance test. A significant difference ($p<0.05$) was seen in muscle strengths of the trunk flexors (mean=17.87,SD=1.86) and trunk extensors(mean=15.93,SD=2.58).

Although there was no significant muscle imbalance seen, but a high correlation(r) was seen between muscles of the dominant vs the other side. Hip flexors(r=0.82), Hip extensors (r=0.83), Hipadductors (r=0.72),Hip abductors(r=0.78), Hip internal rotators(r=0.82), Hip external rotators (r=0.76), Knee flexors (r=0.87), knee extensors (r=0.88), ankle dorsiflexors (r=0.86), invertors (r=0.85) and evertors (r=0.83). No sport specific muscle imbalance is seen in roller skaters. There is a correlation between the muscle strength of left and the non right side of the body in roller skaters.

CONCLUSION

No muscle imbalance persists between the agonist and antagonist muscle groups in roller skaters as a result of the Sport-Related posture maintained by them on field. Although significant correlation can be seen between the muscle strength of the two sides of the body in roller skaters**.**

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