Myoelectrical Comparison of Selected Upper Body Muscles with Different Racket Coverings in Table Tennis While Playing Forehand Flick

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Abstract

A myographical study was conducted on five inter-university female table tennis players (aged 19 ± 2, height 161.4 ± 6.7 cm, weight 59.5 ± 5.7 kg) to determine whether there are differences in muscle activation readings when played with two different racket coverings i.e., inverted and pimpled while playing forehand flick. In this study 6 muscles namely anterior deltoid, bicep brachii, flexor carpi radialis, extensor carpi radialis, pectoralis major, and stomach oblique were selected for the analysis. Root Mean Square (RMS), an EMG signal variable, was analyzed across all muscles to determine maximum muscle involvement. The RMS value was computed to assess muscle activation of each muscle while playing with both racket coverings.A paired t-test method was employed using IBM SPSS 26 to compare the findings at 0.05 significance level. The results showed no significant difference among any of the muscles. Further studies with more elite-level players and more strokesare suggested by the researchers.

KEYWORDS: electromyography, table-tennis, racket covering, forehand flick.

1. Introduction

Table tennis has evolved over time into a sport that places a greater emphasis than ever before on the development of exceptional speed, power, endurance, strength, flexibility, good reflexes, and agility. The top athletes concentrate on attacking or counter-attacking (Kahn et al., 2004). Physical preparation, strength training, and cutting-edge fitness training diagnostic techniques are all significant components of today's sports training programs, particularly for the sport of table tennis(McCann &Bigliani, 1994).

Table tennis is a demanding sport that calls for both physical and mental preparation as well as tactical awareness(Bańkosz&Winiarski, 2017). Table tennis has the same kinds of injuries as other sports. However, research in contemporary sports medicine and sports sciences helps table tennis players identify injuries early and prevent them(Gogoi, Rajpoot, et al., 2021; Gogoi, Borah, et al., 2021). Additionally, it is crucial to comprehend the pathophysiology and functional anatomy of various tissue lesions in order to successfully prevent injuries(Gogoi et al., 2020). It's crucial to comprehend concepts like excessive load and load distribution, sports injury mechanisms, and the biochemical reactions of bodily tissues to overuse and impact in order to prevent injuries(Gogoi, Rajpoot, et al., 2021; Kondrič et al., 2006).

Table tennis coaches and trainers are using numerous training methods and equipment adjustments due to the sport's popularity and demanding nature. Learning the role of muscles during the movements is crucial for a thorough understanding of table tennis.Ogimura (1973) was the first to categorise specific muscles according to the various table tennis skills. The relative dearth of scientific literature on the sport of table tennis necessitated the examination of muscle activation.Several equipment advancements in competitive table tennis over the past two decades have altered the way the game is played(Takeuchi et al., 2002; Zhang & Hohmann, 2004). In order to have the upper hand over the competitors, coaches work to raise the level of play of their players. Coaches use a variety of techniques, one of which is employing various racket covers for the table tennis racket. The four types of rubber surfaces are short pips, long pips, antispin, and inverted.The term "pip" describes a raised, conical-shaped bump on the rubber sheet. Short pips rubber is rubber with tightly spaced, short, wide pips that face outward. This rubber is typically used for blocking and striking strokes. This kind of rubber is used by backhand players who need to improve their control over their opponents' spin. More play styles than in other racket sports are possible thanks to the variety of colors and designs available for racket coverings.Due to the vast variety of covers available, a player typically purchases the blade and rubbers separately. The rubbers are then joined using approved glues to make removal and replacement simple. All players should learn how to construct a racket, even if the majority of shops or dealers will do it for you. To boost their spin and speed, most rubber coverings have a sponge layer beneath them. The combined thickness of the rubber and sponge cannot exceed 4 millimetres(*ITTF Handbook*, 2022; McAfee, 2009).

The two racket coverings, pimpled (with short pips) and inverted, were compared myoelectrically while playing the forehand flick in this study.A null hypothesis was developed with the expectation that no muscle would demonstrate a significantly different amount of muscle activation when using either racket covering.

It was anticipated that this study will assist table tennis players, coaches, trainers, and anyone involved in the sport in thoroughly examining the muscular analyses, which may aid in improving players' performance.

In this study, we have used many abbreviations. For a better understanding, the list of the abbreviations along with their full form is given below:

Abbreviation	Full form
AD	Anterior Deltoid
BB	Bicep Brachii
FCR	Flexor Carpi Radialis
ECR	Extensor Carpi Radialis
PM	Pectoralis Major
SO	Stomach Oblique
EMG	Electromyography
FHF	Forehand Flick
RMS	Root Mean Square

2. Materials and methods

2.1 Study participants

Five female table tennis players from a Lakshmibai NationalInstitute of Physical Education were selected for the study. Their age ranged from 17 to 21 years.

Players were chosen depending on their willto take part.All the players possessed at least five years of playing experience before data collection.The minimum qualification for the participants was Inter-university participation. Hence it was assumed that they possessed adequate skillset and techniques to perform the shots.Prior to the data collection, each player's health and injury condition were evaluated to make sure they were fit enough to perform the skills.The participants were requested to fill out written consent forms before to the study in order to indicate their desire to participate. They were told of the study's methodology and potential results. The departmental research committee gave its approval to the study, which was done as part of doctoral research.

2.2 Study organization

BTS FREE EMG Analyzer (figure 1) was used in order to capture the information on muscle activation(Bioengineering, 2011).

Figure 1 BTS Free EMG Analyzer

The task was explained to every player in detail in advance. The group of players alternated between using inverted and pimpled racket coverings to execute each of the chosen offensive strokes.Before data collection, they were given enough time to warm up the targeted muscles as well as major muscles and take practice shots.According to the drive ability test(Purashwani et al., 2010), a target area measuring 55 x 55 cm was marked (figure 2).

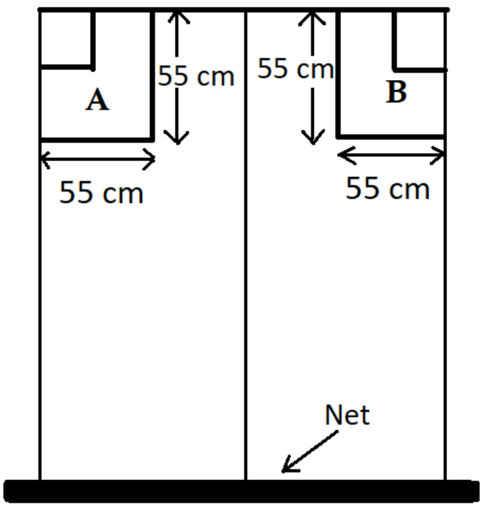

Figure 2 Drive Ability Test by Purashwani et al., 2010

Box 'A' was the target zone for right-hand players, whereas box 'B' was marked for left-hand players. The players' stance was near the opposite court's other half. This was for maintaining accuracy throughout the stroke-playing, so the players would remember the need for accuracy and not hit carelessly. A table tennis ball feeding robot was placed in front to serve the ball. The purpose behind using a ball-feeding robot was that all players should receive the ball at a similar velocity and direction, so the response return does not vary much.

One offensive stroke Forehand flick (FHF) was chosen. EMG electrodes were placed per sEMG protocols (figure 3)(Bioengineering, 2011).Six upper body muscles were analyzed for the study, namely, 1- Anterior deltoid (AD), 2- Bicep brachii (BB), 3- Flexor carpi radialis (FCR), 4- Extensor carpi radialis (ECR), 5- Pectoralis major (PM), and 6- Stomach oblique (SO). The racket coverings chosen were Inverted (without pips) and Pimpled (with short-pips)(shown in *Figure 4*).

Figure 3 Researcher placing EMG electrodes on the subject

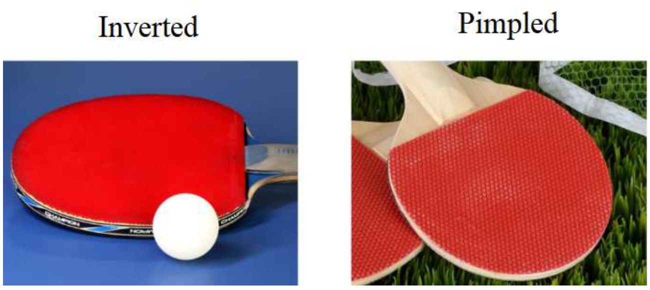

Figure 4 difference between Inverted and Pimpled racket coverings

The robot fed the ball to the players against them repeatedly while they were required to play continuous shots (figure 5). An EMG recording protocol of 10 seconds was set, during which time the muscle activation data is recorded by the EMG analyzer. Analysis was done on the root mean square (RMS) value. Only the trials that maintained accuracy with a 100% success rate were taken into account. No player needed more than two trials because they were all skilled.

Later the EMG signals' analysis was carried out in BTS EMG Analyzer software (version 2.9.40.0). The RMS EMG signals were band-pass filtered using the

Butterworth smoothing technique with a lower cut-off frequency of 20 Hz and a higher cut-off frequency of 400 Hz (Halaki& Gi, 2012) and including electrode configuration distance between electrodes as well as area and shape of the electrodes.

Figure 5 Subject performing Forehand Flick

2.3 Statistical Analysis

The statistical method for comparing the myoelectrical difference in muscle activation during play with both racket coverings was the paired t-test. For descriptive statistics, mean and standard deviation values were taken into account. The level of significance for each statistical calculation was set at 0.05. All statistical evaluations were performed using IBM SPSS Version 26.

3. Results

Below is a table which depicts the descriptive analysis of muscle activation.

Muscle name along with racket covering		**M**	**SD**
Anterior Deltoid	Inverted	441.00	175.07
	Pimpled	412.15	158.72
Bicep Brachii	Inverted	129.58	70.05
	Pimpled	159.23	75.76
Flexor Carpi Radialis	Inverted	144.76	50.54
	Pimpled	149.67	51.83
Extensor Carpi Radialis	Inverted	115.70	42.48
	Pimpled	116.80	39.93
Pectoralis Major	Inverted	288.40	177.25
	Pimpled	322.06	155.66
Stomach Oblique	Inverted	129.33	131.88

	Pimpled	165.34	138.21

M – mean; SD – standard deviation

Table 1 Descriptive Analysis of the muscles (in terms of RMS value)

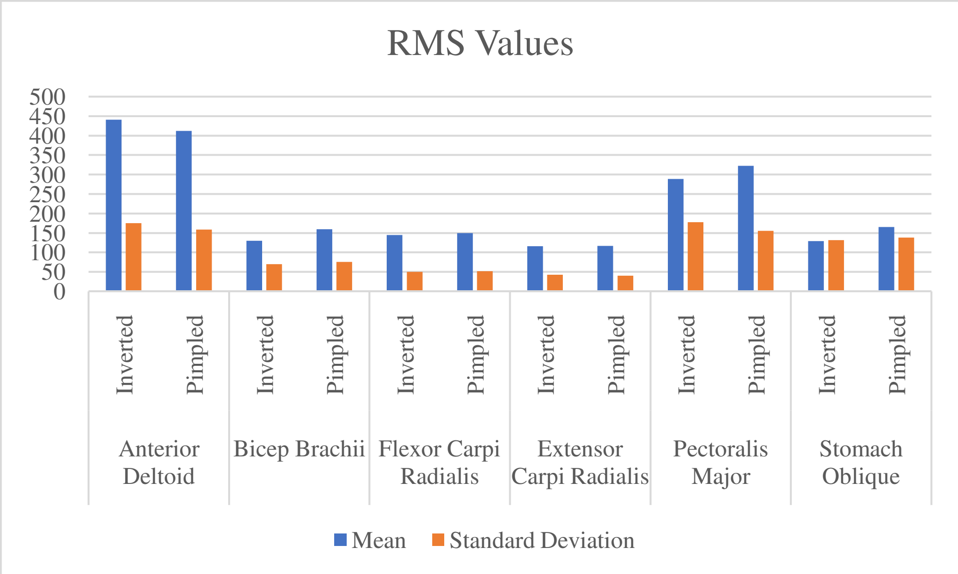

Figure 6 Mean and Standard Deviation of RMS of the Selected Muscles

It was learned from *Table 1, and Figure 6*that the most activated muscle during the FHF was found to be the Anterior Deltoid, whereas the least activated muscle was Extensor Carpi Radialis.Here, inverted (along with muscle name) and pimpled (along with muscle name) describe the muscle involvement while playing with a particular racket covering in Table 1. Further, the graphical representation of the data is shown in figure 6.

The RMS value was used to determine the degree of muscular activation. The collected data was then organised in tabular form (Tables 2 and 3) before the statistical analysis.

	Inverted					
	AD	**BB**	**FCR**	**ECR**	**PM**	**SO**
S1	246.4	100.31	133.48	77.23	164.11	39.08
S2	714.51	231.81	215.05	164.4	265.58	285.28
S3	464.51	139.98	173.87	152.37	319.16	261.59
S4	435.29	136.6	115.32	113.8	572.41	26.48
S5	344.32	39.23	86.12	70.74	120.76	34.26

S* – subject

Table 2 RMS values of selected upper body muscles with Inverted racket covering

	Pimpled					
	AD	**BB**	**FCR**	**ECR**	**PM**	**SO**
S1	213.9	97.13	131.01	80.51	180.53	29.29
S2	651.25	290.71	228.61	169.18	398.12	214.39
S3	445.18	124.39	173.6	148.41	360.85	351.85
S4	390.72	139.6	112.61	102.48	521.49	26.8
S5	359.74	144.36	102.53	83.43	149.32	204.38

S* – subject

Table 3 RMS values of selected upper body muscles with Pimpled racket covering

After entering the numerical data into SPSS 26, a paired t-test was run to determine the results. The paired t-test method with a 0.05 level of significance was employed to compare the findings.

The actual issue, which was to distinguish between the levels of muscular activation in selected upper body muscles while performing a forehand flick stroke, is shown in Table 4.

Muscle	t	df	Sig. (2-tailed)
AD	2.182	4	0.095
BB	-1.301	4	0.263
FCR	-1.178	4	0.304
ECR	-0.268	4	0.802
PM	-1.144	4	0.317
SO	-0.852	4	0.442

Table 4 Results of t-test of RMS between Inverted and Pimpled

Out of 6 selected muscles, none of them showed statistically significant difference.

4. Discussion

The study's results showed that the different racket coverings(inverted and pimpled) had no significant effect on the Root Mean Square values of any of the six selected muscles, including the anterior deltoid, biceps brachii, flexor carpi radialis, extensor carpi radialis, pectoralis major and stomach oblique.

The descriptive statistics showed that maximum RMS (Root Mean Square) in inverted racket covering was shown by Anterior Deltoid (441.00) and minimum RMS in inverted racket covering was shown by Extensor Carpi Radialis (115.70). Whereas the maximum RMS (Root Mean Square) in pimpled racket covering was also shown by Anterior Deltoid (412.15) and the minimum RMS in pimpled racket covering was shown by Extensor Carpi Radialis (116.80).

The researcher concludes that different racket coverings, i.e., inverted and pimpled, have no significant difference in Anterior Deltoid, Biceps Brachii, Flexor Carpi Radialis, Extensor Carpi Radialis, Pectoralis Major and Stomach Oblique muscles.

The researcher advises deeper investigation into the major muscles of the upper and lower body with more attacking and defensive strokes. The different forehand playing styles of the players may account for results that are not statistically significant(Maheshwari et al., 2022). As a result, a study with a high sample size might be carried out to provide an answer. Additionally, elite-level players need to be examined in order to lessen variance.

5. Conclusion

The visible results and graphical presentations of the study showed that none of the six selected upper body muscles, i.e., anterior deltoid, bicep brachii, flexor carpi radialis, extensor carpi radialis, pectoralis major, and stomach obliqueshowed a significant statistical difference in the myoelectrical reading of the muscle activation. And this may be due to the different forehand playing styles of the players, for which a study with greater number of participants may provide more precise answers. The greater muscular activity is concerning since it could signal increased effort and provide a possibility for harm while playing.That is, if a player believes that the ball needs to be hit harder, the player may exert a degree of effort that, if used repeatedly, could result in an injury(Blackwell & Knudson, 2002).

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