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Thickness and Prevalence Rate of White Matter of the Brain as a Biological Marker to Guide the Selection Processes of the Various Playing Positions of the Junior Basketball Players

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Abstract

This research aims to find a way for selecting junior basketball players and guide them to the various playing positions through the prevalence rate and thickness of the white matter in the brain by achieving the following objectives:

- Identifying the thickness and prevalence rate of white matter of the brain in the various playing positions of the junior basketball players.

- Setting the biological determinants according to the thickness and prevalence rate of white matter of the brain for each of the different playing positions among the junior basketball players.

The researcher used the descriptive method for its relevance to the research procedures and objectives. The research sample included 24 juniors from Al-Ittihad Alexandria Basketball Club, who were born in 2002, and were listed in an under-14 years-old team (A) and a 14 years-old team (B). They were selected intentionally and divided into three groups according to the three playing positions (point guard, guard, and post player), and the measurements were conducted during the 2015-2016 season in the period from 7/2/2016 to 11/2/2016, using 1.5 tesla magnetic resonance imaging (MRI), after determining the areas of thickness and prevalence rate of white matter of the brain to obtain the value of the diffusion coefficient and mass size. The results revealed the following points:

1- The guard exceeded the point guard in all of the variables of prevalence rate of the white matter except for the posterior lobe of the inner capsule (PLic)

2- The point guard exceeded the post player in all of the variables of prevalence rate of the white matter except for the deep white matter in the front lobe (DF)

3- The post player exceeded the point guard in the (white matter MO)

Finally the researcher recommended the following:

1- Depending on the thickness index and prevalence rate of white matter of the brain as one of the biological markers of selection in basketball.

2- Developing predictive equations that combine between the physical, neural and technical traits to be a reliable criterion in evaluating the technical performance of basketball players.

Introduction and Research Problem:

Basketball has become one of most popular team sports, that it was included in the Olympic and international games after it was just a recreational game, and as a result of this development, many experts and researchers in the game concerned with its problems in a proper scientific way, so sport training has been based on scientific and educational principles that aim at preparing the player in a comprehensive preparation to achieve the highest athletic level as possible in the sport activity. (20:29)

However, each sport activity has its special requirements that discriminate it from other activities. Superiority and athletic achievement are related to these necessary requirements of the practiced activity, as the champion making system requires a certain physical construction besides the training programs which are based on scientific basics (14:14)

Sport activity depends on the physical, functional, psychological and mental aspects, which is a natural result of the contributions of these aspects combined, as they affect the player's ability and his/her level of performance, therefor several researches and studies concerned with these aspects that help the junior player achieving the higher performance, however this could be done efficiently only through the selection process, prediction and training as well as motivation and activity (9:127)

Since identifying the requirements of sport activity is the main axis to find the optimal criterion for the proper scientifically based selection, by identifying the abilities and skills of the high-level champions and using them as requirements of the sport activity to identify the corporal, physical, motor and psychological abilities and skills to reach the champion's level. (13:629)

Selection is a predictive process based on several abilities and attributes, including physical measurements, some measurements of physical fitness, physiological efficiency, motor and technical level indicators for the top level players, which results in the interaction of these factors in predictive equations that can guide the selection of juniors, and thus achieving the principle of human effort economics in the field of sports. (1:31), (2:77), (4:27-33)

Biological factors are important principles on which sport training is based; also they are essential elements in the selection process of junior players and guiding them to the type of sport activity that is compatible with their capabilities and biological characteristics which are the main determinants for the different phases of selection (17:259)

The nervous system also is an important and vital part in the sport field as it affects the ability of the player to perform on the field as well as dealing with the external environment that can affect his performance, therefore, selection according to the nervous system is one of the modern biological determinants in the selection of juniors according to a perspective different from the traditional methods of selection, depending on the quality of the nerve and the degree of concentration in the body, and to determine the rate of myelin around the nerve, which ensures the speed of the nerve signal within the nerve fibers to achieve the motor performance at the required speed and accuracy. (16:216)

The speed of nerve signal depends on the diameter of the nerve fiber. Large-diameter nerve fibers transmit the nerve signals at a high speed of about 140 m/sec, while the thin nerve fibers transmit nerve signals at a speed of 12 m/sec (21:108)

The human brain consists of three main layers: the cerebral cortex in the surface, which is under the bone, the gray matter between the skin and the white matter, in addition to the white matter inside the center of the brain, which surrounds the central structure of the brain, while the function of the gray matter is to give orders to all organs or the so-called nerve signals and the function of the white matter in the brain is to transfer those signals to the rest of the body (16:12)

Figure (1)
White matter in the brain

The thickness of myelin should be exactly appropriate for the nerve fiber within to achieve the maximum transfer rate of the nerve impulses. The optimal ratio of the nerve fiber included in myelin is 0.6 cm. (18:96)

Recent studies have shown that the size and prevalence rate of white matter within the brain is related to the age and varies from male to female. Motion learning and training can lead to changes in brain structures that are associated with the requirements of sport training, especially in both gray matter and white matter in any practiced exercise. This is obvious in the increase of the size of the cerebral lobes of elite basketball players whose performance requires coordination between their offensive high skills with the ball quickly and accurately, which affects their motor compatibility. (21:89, 201)

In addition to concentration on motor learning myelin leads to changes in the white matter, as the prevalence rate of myelin within the lobe increases due to the increased hours of sport training. Training also affects the skills that require the involvement of more than one motor and sensory element on the white matter in the lower region of the primary motor cortex for the basketball players. (20:172)

Basketball is considered one of the sport activities that require from the players high compatibility between the different parts of the body due to the complex nature of technical performance, which requires high accuracy in performance, this needs special efficiency of the nervous system's performance to deliver nerve signals to more than one part of the body at the same time, therefore the speed of technical performance reflects the capability of the nervous system through the compatibility between the eye and the other body organs to perform these complex skills (18:106, 119)

Thus, the nervous system has the ability to create distinguished athletes, and the most notable example for this is Michael Jordan, an American basketball player whose speed of nerve signal of his wrist joint ranged between 195 to 198 mph (20:79)

Although basketball is characterized by the changing attitudes and various offensive skills which used according to the conditions of the competition, the playing positions of the players and the space of the stadium, players have to perform with certain accuracy and speed according to these conditions. (19:2)

The player's performance is not limited to the accuracy and speed required during the game, but also the player's complex technical performance according to conditions of the game allows him/her to choose the best in the actual positions and training to achieve the prompt performance. (3:2, 3) (11:43)

Lazem and Qassem Abbas (2012) pointed that the basketball player must master the game in different playing positions, but there are some physical and technical elements as well as corporal and physiological specifications that can determine the playing positions of the players as each player has his/her own skills that enable him/her to achieve the tasks in the game (8:362)

Despite the fact that basketball is a collective game as it depends mainly on offensive and defensive performance including participation and cooperation of more than one player in performance, the success of the team depends on functionalization of the players' abilities technically, and physically.

Fatma Mohamed Abdel-Maksoud (1990) pointed that each of the playing positions in the team has certain physical and psychological requirements and abilities. It is also known that the player usually changes his/her place by changing the playing positions and the ball moves. The playing positions are divided into three positions, which are the guard, the post player, and the point guard, and it is necessary for all players to master different techniques in each playing position. (7:108-109)

Also preparing the basketball juniors in the different play positions and planning their programs, which must be commensurate with the level of maturity, growth and development, by training on the offensive motor skills performances that should be acquired by the players in early age due to the high physical and professional skills required. The age under 16 years-old in basketball is considered the beginning of identifying the playing positions of the players, as the mini-basketball and under-14 players play in all positions to acquire several skills to help them specializing in one or more positions at the age under 16 years-old according to their physical and technical abilities. (5:6)

Through the researcher's experience in the field of basketball training, it was found that many trainers determine the playing positions of the players in early stages that do not match the level of maturity and the stages of their growth, which leads to a lack of technical performance in the future, so the researcher recommends to select the basketball players at this stage, which is by the end of 14 years-old for the proper positions when they are at 16. The white matter is one of the biological indicators that play an important role in estimating the rate of progress in achieving the motor-learning related to the technical performance and understanding both offensive and defensive duties as well as implementing them with the required speed and accuracy by selecting the appropriate technique for each position with taking into consideration the harmonization between these techniques. From here the researcher attempted to study the prevalence rate and thickness of white matter and its vital role within the brain as one of the basic components that show the nerve qualities represented by the speed of the nerve signal, which determines the performance of different players, whether offensive or defensive, which distinguish each player from the other in order to select the best individuals and guide them to the appropriate playing positions in light of the performance requirements of the playing positions of basketball, especially in the youth stage, which helps developing and improving the Egyptian basketball.

Research objective:

Identifying a way to select basketball players and guide them to the different playing positions through the prevalence rate and thickness of white matter in the brain by achieving the following objectives:

- Identifying the thickness and prevalence rate of white matter of the brain in the various of the basketball players in the different playing positions.

- Setting biological parameters according to the thickness and prevalence rate of white matter of the brain for each of the different playing positions of the basketball juniors.

Research hypotheses:

- There are significant differences between the different playing positions regarding the prevalence rate of white matter in the brain of the basketball juniors.

- There are significant differences between the different playing positions regarding the thickness and size of white matter in the brain of the basketball juniors.

Research terminology:

Sport selection: is the process of selecting the best junior players who have special preparations and abilities that meet the requirements of the sport activity (20:25)

White matter: is one of the two main components, where the gray matter is the second component and consists mainly of glial cells and axons that are covered by myelin (9:37)

White matter thickness: is a numerical value obtained from Fourier equations that reflects the size of the white matter of the brain in the determined area on the magnetic resonance device (9:81)

White matter prevalence rate: is the numerical degree that does not exceed the right one and indicates the prevalence rate in four directions, horizontally and vertically in the determined areas on the magnetic resonance device (9:96)

Tesla: is the unit of measurement of the magnetic field which was previously called electromagnetic induction and is considered one of the units of the international system. This name was chosen in honor of Nikola Tesla, and the equivalent of the single tesla is 1 Weber per square meter (15:15)

Fourier equations: are biological mathematical process used to convert data from the temporal domain to the frequency domain. It is useful for analyzing nerve signals and identifying the frequencies they contain. (22:160)

Magnetic resonance: is a tomography device that images the parts of the body in clips. (22:129)

Research procedures:

- Research methodology: The researcher used the descriptive approach for its relevance to the research procedures and objectives.

- Research sample: The research sample consisted of 24 juniors from Al-Ittihad Alexandria Basketball Club, who were born in 2002, and were listed in an under-14 years-old team (A) and a 14 years-old team (B). They were purposively selected and divided into three groups according to three playing positions as follows: (8 point guards), (8 guards), (8 post players).

Conditions of selecting the sample:

- Being registered in the Egyptian Basketball Federation

- Being part of the team and has participated in official matches

- Being regular in training without interruption

- The parents must have agreed to conduct the magnetic resonance

- Research domains:

- Temporal domain: 2015-2016 sport season

- From 7/2/2016 to 11/2/2016

- Spatial domain: Diagnostic Radiology Department at the Children’s Hospital of the Faculty of Medicine, Alexandria University

- Research measuring tools:

I) Preliminary measurements

- Height measurement: using a restameter to the nearest cm

- Weight measurement: using a medical balance to the nearest half of a kg

- Age – training age

II) Magnetic resonance measurements of the white matter

The following areas in the brain were determined to identify the thickness and prevalence rate of white matter of the brain by imaging using a 1.5 tesla magnetic resonance device to obtain the prevalence factor and mass size in the following areas:

- Anterior corpus callosum (Acc)

- Posterior corpus callosum (Pcc)

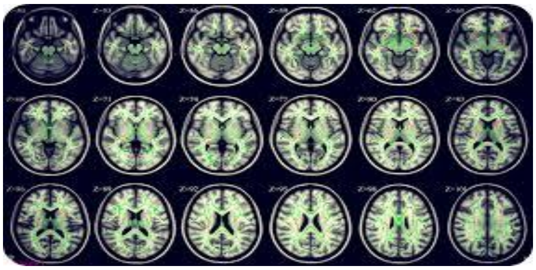
- Posterior lobe of the inner capsule (PLiC)

- Deep white matter in the front lobe (DF)

- Posterior deep white matter (ppv)

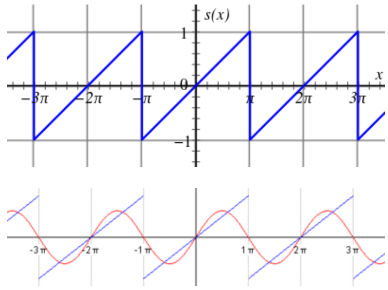
- Deep white matter in the lateral lobe (Df)
- White matter behind the brain center (Pc)
- Anterior surrounding deep white matter (APV)
- White matter in the middle of the front lobe (Mo)
- Outer capsule of the right lobe
- Outer capsule of the left lobe

Figure (2)
The obtained image of the thickness
and prevalence rate of the white matter



The obtained numbers are converted from the temporal domain to the digital frequency domain by using Fourier equations to obtain the numerical value for the rate and thickness of white matter.

Figure (3)
The diagram of Fourier equations



Fourier equations are necessary until today in the field of nerve signal analysis although they have been used since over 200 years.

$$f(x) = \frac{a_0}{2} + \sum_{n=1}^{\infty} [a_n \cos(nx) + b_n \sin(nx)]$$
$$= 2\sum_{n=1}^{\infty} \frac{(-1)^{n+1}}{n} \sin(nx), \quad \text{for} \quad x - \pi \notin 2\pi\mathbf{Z}.$$

Ao, An, and Bn represent a group of consonants, where Ao is the first element of the equation (as n=0, An represents the Cosine coefficient and Bn represents the Sine coefficient)

Presentation and Discussion of the Results:

The following tables show the homogeneity of the research sample according to the three playing positions and the total sample of the research

Table (1)
Statistical description of the data of the research sample according to the playing positions and the total sample in the (preliminary measurements)

Variable	Playing position	Number (N)	Case Summaries				
			Mean	Median	Std. Deviation	Kurtosis	Skewness
Age (years)	Point guard	8	14.38	14.25	0.44	1.48-	0.62
	Guard	8	14.63	14.5	0.69	2.21-	0.27
	Post player	8	14.50	14	0.93	0.00	1.44
	Overall total	24	14.50	14	0.69	0.16-	1.08
Height (cm)	Point guard	8	164.25	164	5.78	2.36	0.08
	Guard	8	172.00	173	4.00	0.70-	0.86-
	Post player	8	181.75	183	3.65	0.25-	1.19-
	Overall total	24	172.67	173	8.52	0.85-	0.22-
Weight (kg)	Point guard	8	53.50	53.5	2.88	1.80-	0.00
	Guard	8	59.50	57	6.65	0.28-	1.22
	Post player	8	75.75	75.5	8.73	1.40-	0.09
	Overall total	24	62.92	57.5	11.46	0.37-	0.88
Training age (years)	Point guard	8	6.50	6.5	0.53	2.80-	0.00
	Guard	8	5.75	5.5	0.89	1.48-	0.62
	Post player	8	5.75	5.5	0.89	1.48-	0.62
	Overall total	24	6.00	6	0.83	1.57-	0.00

Table (1) that represents the statistical description of the data of the research sample according to the playing positions and the total sample in the (preliminary measurements) shows that the values of skewness coefficient ranged from (-1.19 to 1.22), which means that the obtained measurements are close to the mean, since the values of the skewness coefficient range between ±3 and is very close to zero. The kurtosis coefficient ranged between (-2.80 to 2.36), and this means that oscillation of the average curve is acceptable, in the middle, and is not oscillating above or below, which confirms the homogeneity of the research sample according to the playing positions and the total sample in the preliminary measurements.

Table (2)

Statistical description of the data of the research sample according to the playing positions and the total sample in the (prevalence rate of white matter)

Variable	Playing position	Number (N)	Case Summaries				
			Mean	Median	Std. Deviation	Kurtosis	Skewness
Anterior corpus callosum (Acc)	Point guard	8	0.78	0.78	0.01	1.46-	0.00
	Guard	8	0.91	0.91	0.03	0.57-	0.86
	Post player	8	0.69	0.70	0.03	0.70-	0.96-
	Overall total	24	0.79	0.78	0.10	1.03-	0.27
Posterior corpus callosum (Pcc)	Point guard	8	0.86	0.86	0.02	1.02-	0.54
	Guard	8	0.89	0.89	0.02	1.01-	0.00
	Post player	8	0.74	0.75	0.02	0.70-	0.86-
	Overall total	24	0.83	0.86	0.07	1.22-	0.61-
Posterior lobe of the inner capsule (PLiC)	Point guard	8	0.64	0.64	0.03	0.70-	0.00
	Guard	8	0.66	0.66	0.03	1.05-	0.26
	Post player	8	0.61	0.61	0.02	0.86-	0.40
	Overall total	24	0.64	0.64	0.04	0.42-	0.41
Deep white matter in the front lobe (DF)	Point guard	8	0.48	0.47	0.03	1.88-	0.34
	Guard	8	0.52	0.51	0.03	0.36-	1.15
	Post player	8	0.46	0.47	0.03	0.57-	0.86-
	Overall total	24	0.48	0.49	0.04	0.06	0.06
Anterior surrounding deep white matter (APV)	Point guard	8	0.29	0.29	0.03	0.86-	0.00
	Guard	8	0.39	0.39	0.02	1.20-	0.62-
	Post player	8	0.25	0.26	0.03	0.70-	0.68-
	Overall total	24	0.31	0.29	0.06	1.11-	0.36
Posterior deep white matter (ppv)	Point guard	8	0.51	0.51	0.03	0.70-	0.68
	Guard	8	0.63	0.62	0.02	1.20-	0.62
	Post player	8	0.47	0.47	0.02	1.02-	0.54
	Overall total	24	0.53	0.51	0.07	1.27-	0.53
White matter in the middle of the front lobe (Mo)	Point guard	8	0.48	0.49	0.02	0.70-	0.86-
	Guard	8	0.71	0.70	0.04	0.84-	0.72
	Post player	8	0.64	0.64	0.01	1.46-	0.00
	Overall total	24	0.61	0.64	0.10	1.24-	0.31-
Deep white matter in the lateral lobe (Df)	Point guard	8	0.75	0.75	0.02	0.70-	0.00
	Guard	8	0.83	0.83	0.02	1.46	0.00
	Post player	8	0.68	0.69	0.03	0.70-	0.55-
	Overall total	24	0.75	0.75	0.07	0.84-	0.10-

Table (2) that represents the statistical description of the data of the research sample according to the playing positions and the total sample in the (prevalence rate of white matter) shows that the values of skewness coefficient ranged from (-0.96 to 1.15), which means that the obtained measurements are close to the mean, since the values of the skewness coefficient range between ±3 and is very close to zero. The kurtosis coefficient ranged between (-1.88 and 1.46), and this means that oscillation of the average curve is acceptable, in the middle, and is not oscillating above or below, which confirms the homogeneity of the research sample according to the playing positions and the total sample in the prevalence rate of white matter.

Table (3)
Statistical description of the data of the research sample according to the playing positions and the total sample in the (thickness and size of white matter of the brain)

Variable	Playing position	Number (N)	Case Summaries				
			Mean	Median	Std. Deviation	Kurtosis	Skewness
Anterior corpus callosum (Acc)	Point guard	8	85.88	86.96	3.73	0.89-	0.87-
	Guard	8	76.00	76.01	2.78	0.76-	0.02-
	Post player	8	72.78	73.07	1.72	1.07-	0.56-
	Overall total	24	78.22	76.01	6.32	0.94-	0.66
Posterior corpus callosum (Pcc)	Point guard	8	119.88	120.26	2.33	1.42-	0.48-
	Guard	8	122.87	122.79	1.34	1.22-	0.19
	Post player	8	110.72	109.45	3.60	0.43-	1.13
	Overall total	24	117.82	120.22	5.83	0.97-	0.72-
Posterior lobe of the inner capsule (PLiC)	Point guard	8	285.31	286.13	3.29	0.55-	0.90-
	Guard	8	291.71	290.47	5.71	0.58-	0.80
	Post player	8	281.73	280.81	2.50	0.35-	1.18
	Overall total	24	286.25	285.65	5.74	1.18	1.06
Deep white matter in the front lobe (DF)	Point guard	8	244.69	244.40	3.67	1.19-	0.28
	Guard	8	263.40	261.80	4.52	0.64-	1.04
	Post player	8	255.05	255.62	3.21	0.56-	0.68-
	Overall total	24	254.38	255.62	8.63	0.69-	0.02
Anterior surrounding deep white matter (APV)	Point guard	8	326.10	325.95	3.06	0.89-	0.19
	Guard	8	350.54	350.82	7.62	0.71-	0.15-
	Post player	8	319.28	319.26	2.43	1.52-	0.02
	Overall total	24	331.97	325.95	14.50	0.78-	0.82
Posterior deep white matter (ppv)	Point guard	8	172.86	173.57	3.82	1.67-	0.46-
	Guard	8	202.32	202.32	5.35	0.87-	0.00
	Post player	8	178.36	178.24	1.55	1.99-	0.19
	Overall total	24	184.51	178.24	13.58	1.03-	0.71
White matter in the middle of the front lobe (Mo)	Point guard	8	872.47	871.13	5.24	0.75-	0.86
	Guard	8	933.62	933.92	5.41	1.00-	0.20-
	Post player	8	755.00	754.67	11.81	1.30-	0.09
	Overall total	24	853.70	871.13	76.11	1.50-	0.41-
Deep white matter in the lateral lobe (Df)	Point guard	8	1031.84	1032.36	7.00	1.06-	0.27-
	Guard	8	1147.89	1149.46	10.73	0.63-	0.57-
	Post player	8	1130.19	1131.56	5.30	0.87-	0.82-
	Overall total	24	1103.31	1131.06	52.71	1.50-	0.65-

Table (3) that represents the statistical description of the data of the research sample according to the playing positions and the total sample in the (thickness and size of white matter of the brain) shows that the values of skewness coefficient ranged from (-0.82 to 1.18), which means that the obtained measurements are close to the mean, since the values of the skewness coefficient range between ±3 and is very close to zero. The kurtosis coefficient ranged between (1.99 to 1.18), and this means that oscillation of the average curve is acceptable, in the middle, and is not oscillating above or below, which confirms the homogeneity of the research sample according to the playing positions and the total sample in the thickness and size of white matter of the brain.

Presentation and Discussion of the Results:

Analysis of variance of the three playing positions (point guard, guard, and post player) in the prevalence rate of the white matter

Table (4)
Analysis of variance (ANOVA) of the three playing positions (point guard, guard,and post player) in the (prevalence rate of the white matter)

Variables	Source of variance	Degrees of freedom	Total of squares	Mean of squares	P value	Significance level	Index
Anterior corpus callosum (Acc)	Between positions	2	0.2017	0.1009	*136.20	0.00	Significant
	Inside positions	21	0.0156	0.0007			
	Total	23	0.2173				
Posterior corpus callosum (Pcc)	Between positions	2	0.0949	0.0475	*139.36	0.00	Significant
	Inside positions	21	0.0072	0.0003			
	Total	23	0.1021				
Posterior lobe of the inner capsule (PLiC)	Between positions	2	0.0122	0.0061	*6.87	0.01	Significant
	Inside positions	21	0.0187	0.0009			
	Total	23	0.0309				
Deep white matter in the front lobe (DF)	Between positions	2	0.0139	0.0070	*6.97	0.00	Significant
	Inside positions	21	0.0210	0.0010			
	Total	23	0.0349				
Anterior surrounding deep white matter (APV)	Between positions	2	0.0785	0.0393	*57.26	0.00	Significant
	Inside positions	21	0.0144	0.0007			
	Total	23	0.0929				
Posterior deep white matter (ppv)	Between positions	2	0.1062	0.0531	*100.04	0.00	Significant
	Inside positions	21	0.0112	0.0005			
	Total	23	0.1174				
White matter in the middle of the front lobe (Mo)	Between positions	2	0.2161	0.1081	*177.96	0.00	Significant
	Inside positions	21	0.0128	0.0006			
	Total	23	0.2289				
Deep white matter in the lateral lobe (Df)	Between positions	2	0.0901	0.0451	*59.15	0.00	Significant
	Inside positions	21	0.0160	0.0008			
	Total	23	0.1061				

* Significant at 0.05 = 3.47

Table (4) and Figure (1) that represent the analysis of variance of the three playing positions (point guard, guard, and post player) in the prevalence rate of the white matter show significant differences between the three playing positions in all of the variables (prevalence rate of the white matter), and (P) value ranged between (6.87 to 177.96), and this value is greater than the tabulated (P) value at 0.05. The least significant difference (LSD) test was used to determine the significance of difference between the three playing positions in the prevalence rate of the white matter in table (5).

Table (5)
Significant differences between the three playing positions (point guard, guard, and post player) in the prevalence rate of the white matter using the LSD test

Variables	Playing positions	Arithmetic mean	Standard deviations	Significant differences between the means			LSD value
				Point guard	Guard	Post player	
Anterior corpus callosum (Acc)	Point guard	0.78	0.01		*0.13	*0.09	0.03
	Guard	0.91	0.03			*0.22	
	Post player	0.69	0.03				
Posterior corpus callosum (Pcc)	Point guard	0.86	0.02		*0.03	*0.12	0.02
	Guard	0.89	0.02			*0.15	
	Post player	0.74	0.02				
Posterior lobe of the inner capsule (PLiC)	Point guard	0.64	0.03		0.02	*0.03	0.03
	Guard	0.66	0.03			*0.05	
	Post player	0.61	0.02				
Deep white matter in the front lobe (DF)	Point guard	0.48	0.03		*0.04	0.02	0.03
	Guard	0.52	0.03			*0.06	
	Post player	0.46	0.03				
Anterior surrounding deep white matter (APV)	Point guard	0.29	0.03		*0.10	*0.04	0.03
	Guard	0.39	0.02			*0.14	
	Post player	0.25	0.03				
Posterior deep white matter (ppv)	Point guard	0.51	0.03		*0.12	*0.04	0.02
	Guard	0.63	0.02			*0.16	
	Post player	0.47	0.02				
White matter in the middle of the front lobe (Mo)	Point guard	0.48	0.02		*0.23	*0.16	0.03
	Guard	0.71	0.04			*0.07	
	Post player	0.64	0.01				
Deep white matter in the lateral lobe (Df)	Point guard	0.75	0.02		*0.08	*0.07	0.03
	Guard	0.83	0.02			*0.15	
	Post player	0.68	0.03				

Table (5) and figure (1) that represent the significant differences between the three playing positions (point guard, guard, and post player) in the prevalence rate of the white matter using the LSD test showed that:

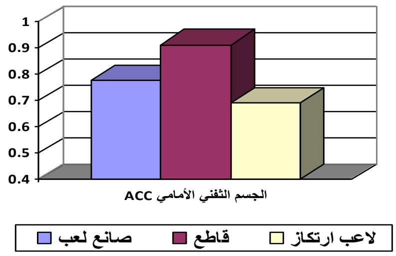
- The guard exceeded the point guard in all of the variables of prevalence rate of the white matter except for the posterior lobe of the inner capsule (PLic)

- The point guard exceeded the post player in all of the variables of prevalence rate of the white matter except for the deep white matter in the front lobe (DF)

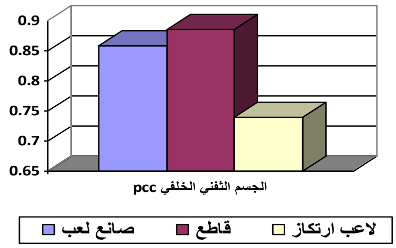
- The post player exceeded the point guard in the (white matter MO)

- The guard exceeded the post player in all of the variables

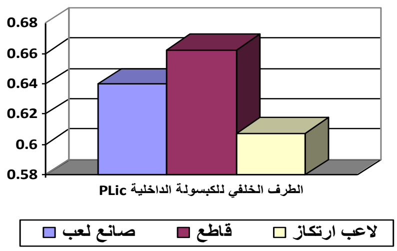
Figure (1)
Significance of the three playing positions (point guard, guard, and post player) in the prevalence rate of the white matter



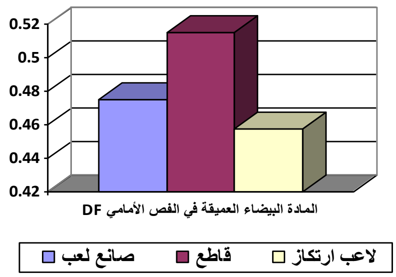
Anterior corpus callosum (ACC)
Point guard Guard Post player



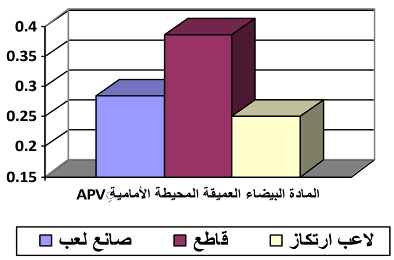
Posterior corpus callosum (PCC)
Point guard Guard Post player



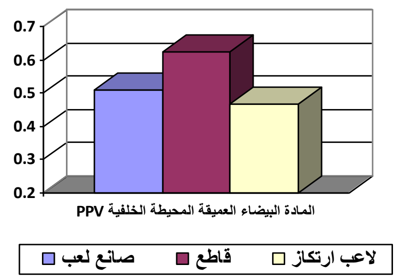
Posterior lobe of the inner capsule (PLiC)
Point guard Guard Post player



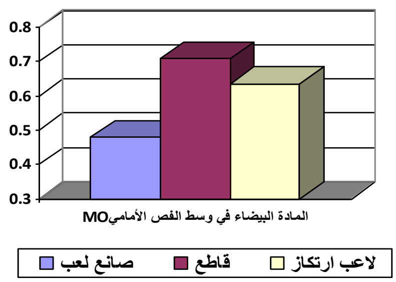
Deep white matter in the front lobe (DF)
Point guard Guard Post player



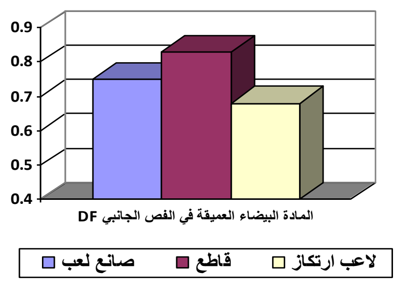
Anterior surrounding deep white matter (APV)
Point guard Guard Post player



Posterior deep white matter (PPV)
Point guard Guard Post player



White matter in the middle of the front lobe (Mo)
Point guard Guard Post player



Deep white matter in the lateral lobe (Df)
Point guard Guard Post player

Analysis of variance between the three playing positions (point guard, guard, and post player) in the thickness and size of the white matter of the brain

Table (6)
Analysis of variance (ANOVA) between the three playing positions (point guard, guard, and post player) in the (thickness and size of the white matter of the brain)

Variables	Source of variance	Degrees of freedom	Total of squares	Mean of squares	P value	Significance level	Index
Anterior corpus callosum (Acc)	Between positions	2	746.19	373.09	*45.53	0.00	Significant
	Inside positions	21	172.08	8.19			
	Total	23	918.27				
Posterior corpus callosum (Pcc)	Between positions	2	640.78	320.39	*47.71	0.00	Significant
	Inside positions	21	141.02	6.72			
	Total	23	781.80				
Posterior lobe of the inner capsule (PLiC)	Between positions	2	408.84	204.42	*12.35	0.00	Significant
	Inside positions	21	347.72	16.56			
	Total	23	756.56				
Deep white matter in the front lobe (DF)	Between positions	2	1404.62	702.31	*47.74	0.00	Significant
	Inside positions	21	308.94	14.71			
	Total	23	1713.57				
Anterior surrounding deep white matter (APV)	Between positions	2	4324.77	2162.38	*88.52	0.00	Significant
	Inside positions	21	512.98	24.43			
	Total	23	4837.75				
Posterior deep white matter (ppv)	Between positions	2	3924.72	1962.36	*129.05	0.00	Significant
	Inside positions	21	319.32	15.21			
	Total	23	4244.05				
White matter in the middle of the front lobe (Mo)	Between positions	2	131854.92	65927.46	*1008.72	0.00	Significant
	Inside positions	21	1372.51	65.36			
	Total	23	133227.42				
Deep white matter in the lateral lobe (Df)	Between positions	2	62544.26	31272.13	*488.00	0.00	Significant
	Inside positions	21	1345.74	64.08			
	Total	23	63890.00				

* Significant at 0.05 = 3.17

Table (6) and figure (2) that represent the analysis of variance of the three playing positions (point guard, guard, and post player) in the thickness and size of the white matter of the brain show significant differences between the three playing positions in all of the variables (thickness and size of the white matter of the brain), and (P) value ranged between (12.35 to 1008.72), and this value is greater than the tabulated (P) value at 0.05. The least significant difference (LSD) test was used to determine the significance of difference between the three playing positions in the prevalence rate of the white matter in table (7).

Table (7)
significance of differences between the three play positions (point guard, guard, and post player) in the thickness and size of white matter of the brain using the LSD test

Variables	Playing positions	Arithmetic mean	Standard deviations	Significant differences between the means			LSD value
				Point guard	Guard	Post player	
Anterior corpus callosum (Acc)	Point guard	85.88	3.73		*9.88	*13.10	2.98
	Guard	76.00	2.78			*3.22	
	Post player	72.78	1.72				
Posterior corpus callosum (Pcc)	Point guard	119.88	2.33		*2.99	*9.16	2.69
	Guard	122.87	1.34			*12.15	
	Post player	110.72	3.60				
Posterior lobe of the inner capsule (PLiC)	Point guard	285.31	3.29		*6.40	3.58	4.23
	Guard	291.71	5.71			*9.98	
	Post player	281.73	2.50				
Deep white matter in the front lobe (DF)	Point guard	244.69	3.67		*18.71	*10.36	3.99
	Guard	263.40	4.52			*8.35	
	Post player	255.05	3.21				
Anterior surrounding deep white matter (APV)	Point guard	326.10	3.06		*24.44	*6.83	5.14
	Guard	350.54	7.62			*31.27	
	Post player	319.28	2.43				
Posterior deep white matter (ppv)	Point guard	172.86	3.82		*29.46	*5.50	4.06
	Guard	202.32	5.35			*23.96	
	Post player	178.36	1.55				
White matter in the middle of the front lobe (Mo)	Point guard	872.47	5.24		*61.15	*117.47	8.41
	Guard	933.62	5.41			*178.62	
	Post player	755.00	11.81				
Deep white matter in the lateral lobe (Df)	Point guard	1031.84	7.00		*116.05	*98.35	8.33
	Guard	1147.89	10.73			*17.70	
	Post player	1130.19	5.30				

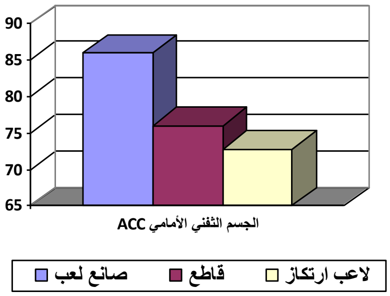
Table (7) and figure (2) that represent the significant differences between the three playing positions (point guard, guard, and post player) in the thickness and size of white matter of the brain using the LSD test, which has always been in favor to the greatest mean showed that:

- The guard exceeded the point guard in all of the variables of prevalence rate of the white matter except for the anterior corpus callosum (Acc), where the point guard exceeded the guard

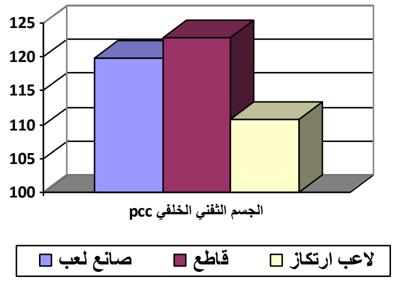
- The point guard exceeded the post player in all of the variables of prevalence rate of the white matter except for the deep white matter in the front lobe (DF) and the posterior deep white matter (ppv)

- The guard exceeded the post player in all of the variables

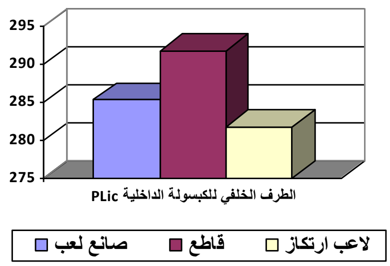
Figure (2)
Arithmetic mean of the three playing positions (point guard, guard, and post player) in the thickness and size of white matter of the brain



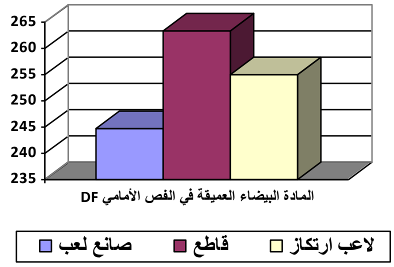
Anterior corpus callosum (ACC)
Point guard Guard Post player



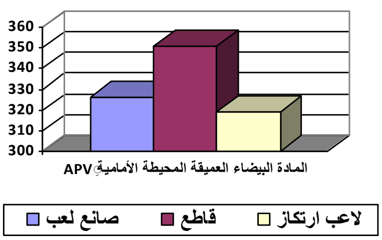
Posterior corpus callosum (PCC)
Point guard Guard Post player



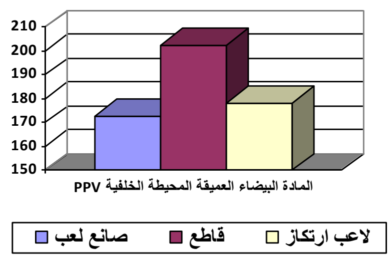
Posterior lobe of the inner capsule (PLiC)
Point guard Guard Post player



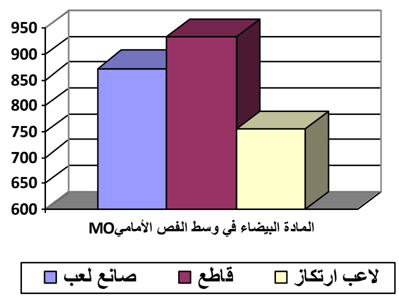
Deep white matter in the front lobe (DF)
Point guard Guard Post player



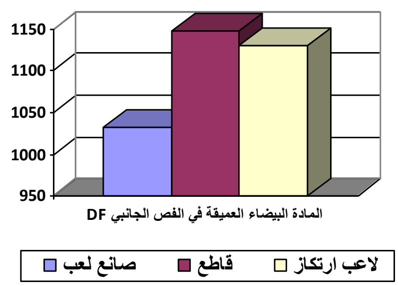
Anterior surrounding deep white matter (APV)
Point guard Guard Post player



Posterior deep white matter (PPV)
Point guard Guard Post player



White matter in the middle of the front lobe (Mo)
Point guard Guard Post player



Deep white matter in the lateral lobe (Df)
Point guard Guard Post player

Presentation of the results of tables (4) and (5) show the following:

- The guard exceeded the point guard in all of the variables except in the (posterior lobe of the inner capsule PLic) and the researcher believes that the guards are the most effective during the attack and the most responsible ones for finishing the attacks, because they have the necessary offensive skills and able to execute them efficiently, accurately, and quickly. This conforms to Markham (2009) as he confirms that performing the complex skills require high accuracy and compatibility between the eye and the different organs of the body in order to implement those complex skills and this requires special efficacy for the performance of the nervous system to transfer nerve signals to more than one part of the body parts at the same time (18:106)

- The researcher believes that the guard did not exceed the point guard in the (posterior lobe of the inner capsule, PLic) due to what Collins (2002) pointed to that the structure of the white matter which is located at the medial lower part within the brain and contains nerve fibers of which some of them provide the spatial vision in three directions (12:51)

- This conforms to the place of the point guard where he is located in the region between the middle of the pitch and the free throw line, he is also considered the last striker so that the perimeter of his vision has three dimensions where he sees the two sides and the guards as well as the third dimension below the basket where the post players stay, so he can see all the players to start performing the team’s passes in different directions as determined by the defenders’ position.

- The point guard exceeded the post player in all of the variables except in the (deep white matter in the front lobe, DF), and the researcher believes that he has special skills and abilities that the post player does not has, because the point guard or position (1) is the shortest and fastest player in the team, and he is often the best player in dribbling as he possesses the ball most of the time, he is the leader of the team and controls the pace of the game and determines the plans, and must be good at shooting from the three point area. (24:1)

- The researcher also believes that the post player’s excess in the variable of (deep white matter in the front lobe, DF) over the point guard is due to the obvious physical difference between them as the post player is taller and has greater mass of weight than the point guard, therefor he has physiological requirements that differ from those of the point guard, which meets with Walters (2007) who pointed that the deep white matter in the front lobe (DF) is organizing the unconscious vital processes of the body at the same time, such as regulating the heart pulse, respiration and digestion (23:4)

- The guard exceeded the post player in all of the variables, and the researcher believes that the guard’s position lets him have the techniques of the point guard as well as the ability of dribbling and good shooting, in addition, some of the tall guards help the post players to take possession of the ball, and thus have more motor skills than the post players have whose playing area is limited in the restricted area which make it hard to perform several skills. This conforms to what Mohamed Abdel-Rehim (1989) pointed to, that the restricted area is the place of the post player’s attacks, and because the area is narrow and crowded with defenders, most of the post players’ attacks depend on the feet for movements and rotation without using dribbling inside the restricted area, so the post player does not lose the ball due to the crowd and defense coverage. (6:352, 353)

Presentation of the results of tables (6) and (7) show the following:

The point guard exceeded the post players in all of the variables except in (deep white matter in the front lobe, DF), and the (posterior deep white matter, ppv). This conforms to Baser (2002) when he pointed that the posterior deep white matter decreases the blood consumption for about 15% of the circulatory system of about 7200 liters of blood per day which is pumped by the heart during the sport activities that require a long physical time (10:15)

This is consistent with the scientific studies that confirmed that the distance that the player takes during the two halves of the game in a 28m length and 15m width stadium range between 5-8km, and this happens quickly back and forth along the stadium, as well as executing the required defensive and offensive duties during the game. (17:259)

In addition to this, the physical characteristics of the post players that makes them the most exhausted players, so the post player’s excess in this variable is appropriate for the nature of physical composition and his relation to the size of work in the game.

Conclusions:

1- The guard exceeded the point guard in all of the variables of prevalence rate of the white matter except for the posterior lobe of the inner capsule (PLic).

2- The point guard exceeded the post player in all of the variables of prevalence rate of the white matter except for the deep white matter in the front lobe (DF).

3- The post player exceeded the point guard in the (white matter MO).

4- The guard exceeded the point guard in all of the variables of prevalence rate of the white matter except for the anterior corpus callosum (Acc), where the point guard exceeded the guard.

5- The point guard exceeded the post player in all of the variables of prevalence rate of the white matter except for the deep white matter in the front lobe (DF) and the posterior deep white matter (ppv).

6- The guard exceeded the post player in all of the variables of prevalence rate and size of the white matter.

Recommendations:

1- Depending on the thickness index and prevalence rate of white matter of the brain as one of the biological markers of selection in basketball.

2- Further scientific research on the effect of sport training on the brain as one of the most important organs that God has gifted to the man.

3- Studying the changes that occur in the human brain, especially to the sport champions with respect to the requirements of sport activity.

4- Developing predictive equations that combine between the physical, neural and technical traits to be a reliable criterion in evaluating the technical performance of basketball players.

Arabic and Foreign References:

1- Abu-Elela Ahmed Abdel-Fattah: Physiology of Sport Training, Reference Series in Physical Education, First Edition, Dar Al-Fikr Al-Araby, Cairo, 2003.

2- Abu-Elela Ahmed Abdel-Fattah: Sport Training, Physiological Basics, Dar Al-Fikr Al-Araby, Cairo, 1997.

3- Amrallah El-Bussaty: Analytical study of the types of motor performances in some of the collective sports during the game, unpublished PhD thesis, Faculty of Physical Education for Boys, Alexandria University, 1994.

4- Khalid Abdel-Raouf Obada: Weightlifting for youths, Aamer for printing, Mansoura, (2004).

5- Mohamed Samir Hussein Sowidan: A study of the offensive motor performances for the youth basketball post players, Master's thesis, Faculty of Physical Education for Boys, Alexandria University, 2011.

6- Mohamed Abdel-Rehim Ismail: A study of some types of deception before shooting and their effectiveness on basketball post players, Theories and applications, a scientific journal in physical education science, no. 7, Alexandria University, 1989.

7- Fatma Mohamed Abdel-Maksoud: Determining the specific fitness elements and their contribution to each of the playing positions in basketball, Journal of sport sciences and arts, Faculty of Physical Education for Girls, vol. 2, no. 3, Cairo, 1990.

8- Lazem Mohamed Abbas and Qassem Mohamed Abbas: The relationship between the specific physical abilities of technical performance according to the different playing positions of basketball players, Al-Qadisiyah journal of physical education sciences, vol. 12, no. 1, 2012.

9- Abdul-Kareem IA, Stancak A, Parkes LM, Al-Ameen M, Alghamdi J, Aldhafeeri FM, Embleton K, Morris D, Sluming V. Plasticity of the superior and middle cerebellar peduncles in musicians revealed by quantitative analysis of volume and number of streamlines based on diffusion tensor tractography. Cerebellum. 2011,

10- Baser PJ, Jones DK. Diffusion-tensor MRI: theory, experimental design and data analysis - a technical review. NMR Biomed 2002,

11- Bop Davis Others : physical education and the study of sports.ed mosby.M.S.H , 1995

12- Collins MW, Lovell MR, Iverson GL, Cantu RC, Maroon JC, Field M. Cumulative effects of concussion in high school athletes. Neurosurgery 2002,

13- Di X, Zhu S, Jin H, Wang P, Ye Z, Zhou K, Zhuo Y, Rao H. Altered resting brain function and structure in professional badminton players. Brain Connect. 2012,

14- Fields RD. White matter in learning, cognition and psychiatric disorders. Trends Neurosci.2008,

15- Hihara S, Notoya T, Tanaka M, Ichinose S, Ojima H, Obayashi S, Fujii N, Iriki A. Extension of corticocortical afferents into the anterior bank of the intraparietal sulcus by tool-use training in adult monkeys. Neuropsychological. 2006,

16- Ishibashi T, Dakin KA, Stevens B, Lee PR, Kozlov SV, Stewart CL, Fields RD. Astrocytes promote myelination in response to electrical impulses. Neuron. 2006, 17- Johansen-Berg H, Della-Maggiore V, Behrens TE, Smith SM, Paus T. Integrity of white matter in the corpus callosum correlates with bimanual co-ordination skills. Neuroimage.2007,

18- Markham JA, Herting MM, Luszpak AE, Juraska JM, Greenough WT. Myelination of the corpus callosum in male and female rats following complex environment housing during adulthood. Brain Res. 2009,

19- Marusak,Lenore, Relationship between Morphological physical Fitness &Motor Ability Measure to USA, Sec-Ram Kings in Female Junior Tennis players, California State University, Long Beach 1995.

20- Park IS, Lee KJ, Han JW, Lee NJ, Lee WT, Park KA, Rhyu IJ. Activity white matter in the cerebellum have elite athletes in American basketball. 2009;8:334–339-2015

21- Quallo MM, Price CJ, Ueno K, Asamizuya T, Cheng K, Lemon RN, Iriki A. Gray and white matter changes associated with tool-use learning in macaque monkeys. Proc Natl Acad Sci U S A. 2009,

22- Szeligo F, Leblond CP. Response of the three main types of glial cells of cortex and corpus callosum in rats handled during suckling or exposed to enriched, control and impoverished environments following weaning. J Comp Neurol. 1977,

23- Walters, FJM. "Intracranial Pressure and Cerebral Blood Flow." Physiology. Issue 8, Article 4. Accessed January, 2007.

24- www.wiki.answers.com/Q/what-are-the-various-positions-in-basketball