Electrophysiological changes in children with different subtypes of Attention Deficit Hyperactivity Disorder

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Abstract:

Attention Deficit Hyperactivity Disorder (ADHD) is the most common psychiatric disorder of childhood. This study investigated the Electroencephalography (EEG) changes among different subtypes of attention deficit hyperactivity disorder children. The study group (60 children) was divided into three subgroups according to the 3 subtypes of ADHD. All children were between the ages of 5 and 14 years. EEG was recorded during an eyes-closed resting condition. The present study revealed that 47% of all ADHD groups showed electroencephalographic changes. There were significant differences among ADHD subtypes regarding intensity of LT frontal alpha wave, which was significantly increased in combined ADHD group more than in inattention and hyperactive-impulsive ADHD groups, but there were no significant differences between ADHD subtypes regarding intensity of other EEG waves.

Keywords: Attention Deficit Hyperactivity Disorder (ADHD)- Subtypes- Children- Electroencephalography (EEG)- alpha wave.

التغيرات الكهروفسيولوجية للمخ فى الأطفال المصابين بمختلف أنواع إضطراب فرط الحركة ونقص الإنتباه

المقدمة: يعتبر إضطراب فرط الحركة ونقص الإنتباه من أكثر الإضطرابات السلوكية والمعرفية النمائية التطورية شيوعا عند الأطفال والمراهقين، وتصل نسبة الإصابة به إلى٣% إلى ٧% من الأطفال، وتزيد نسبة انتشاره لدى الذكور عنها لدى الإناث.

ويتميز هذا الإضطراب بأعراض مرضية سلوكية تتمثل فى فرط الحركة والنشاط الزائد ونقص الانتباه والإندفاعية والتى تبدأ فى مرحلة الطفولة وغالبا ما تستمر لمرحلة المراهقة والبلوغ، وهذه الأعراض تؤدى إلى صعوبات فى التأقلم مع الحياة فى المنزل والشارع والمدرسة وفى المجتمع بصفة عامة.

ليس هناك سبب واضح ومحدد لحدوث الإضطراب، فليس هناك عيوب واضحة فى الجهاز العصبي، ولكن هناك أتفاق بين العلماء ان الحالة تحدث نتيجة لأسباب نمائية وتركيبية للجهاز العصبي، وقد أثبتت الدراسات الحديثة أن المشكلة تكمن فى ضعف الموصلات العصبية خصوصاً فى الفص المخى الأمامي، وتؤثرعلى القدرة المعرفية والسلوك الحركى لهؤلاء الأطفال. ويمكن تصنيف الأسباب المؤدية لحدوث الحالة إلى: الأسباب الوراثية والجينية- الأسباب العضوية- الأسباب النفسية- الأسباب البيئية والاجتماعية. ويعتبرالرسم التخطيطى للمخ بواسطة إستخدام جهاز رسم المخ الكهربى وسيلة فعالة لقياس التغيرات الكهروفسيولوجية فى المخ التى قد تصاحب هذا الإضطراب عند هؤلاء الأطفال.

الهدف من الدراسة: استهدفت هذه الدراسة دراسة التغيرات الكهروفسيولوجية للمخ فى الأطفال المصابين بمختلف أنواع إضطراب فرط الحركة ونقص الإنتباه.

منهج الدراسة: الدراسة وصفية تحليلية.

العينة الدراسية: شملت هذه الدراسة ٦٠ طفل من الجنسين، ويتراوح أعمارهم بين (٥- ١٤) عام، وتم تقسيمهم وفقا لخصائص هذا الإضطراب إلى ٣ مجموعات (مجموعة نقص الإنتباه وضعف التركيز وشملت ١٩ طفل (٩ ذكور و١٠ إناث)، ومجموعة فرط الحركة والإندفاعية وشملت ٢٣ طفل (١٨ ذكور و٥ إناث)، ومجموعة فرط الحركة والإندفاعية ونقص الإنتباه المزدوج الكامل وشملت ١٨ طفل (١٢ ذكور و٦ إناث).

الأدوات: التاريخ المرضى للأطفال، والفحص الإكلينيكى الكامل والتقييم العصبى للأطفال، ورسم المخ الكهربى لقياس التغيرات الكهروفسيولوجية فى المخ.

النتائج: أهم النتائج التى توصلت إليها الدراسة كانت أن نسبة وجود هذا الإضطراب فى الذكورأكثر من الإناث (١،٩- ١) وأن الحالات التى تتميز بزيادة فى نقص الإنتباه أكثر شيوعا فى الإناث وأن الحالات التى تتميز بالنشاط الزائد والإندفاعية أكثر شيوعا فى الذكور، وأن التغيرات الكهروفسيولوجية للمخ قد وجدت فى٤٧% من كل المجموعات مع عدم وجود فرق بين الذكور والإناث، وأن هناك فرق بين المجموعات بالنسبة لقوة موجات ألفا الأمامية اليسرى والتى تزيد فى مجموعة الأطفال الذين يعانون من إضطراب فرط الحركة ونقص الإنتباه المزدوج الكامل عن المجموعات الأخرى، لكن لايوجد فروق مهمة بين المجموعات وبعضها بالنسبة لقوة الموجات الكهروفسيولوجية الأخرى.

الكلمات المفتاحية: إضطراب فرط الحركة ونقص الإنتباه- الرسم التخطيطى الكهربى للمخ- الأطفال- التغيرات الكهروفسيولوجية للمخ.

Introduction:

Attention deficit hyperactivity disorder (ADHD) is the most common emotional, cognitive and behavioral disorder in children (Spencer et al., 2007). Epidemiological studies indicate that ADHD affects (3-7%) of all children in the general population (Rappley, 2005).

ADHD is characterized primarily by behavioral symptoms of inattention, hyperactivity, and impulsivity beginning in childhood and often persisting across the life cycle (Biederman, 2005).

Although its etiology remains unclear, it is widely accepted that ADHD results from a dysfunction of the central nervous system, although the nature of this dysfunction is not entirely understood (Barry et al., 2003).

Several studies have demonstrated that individuals with ADHD exhibit increases in slow- wave activity, particularly in the frontal regions of the brain, which is sometimes accompanied by a decrease in fast wave activity in the posterior region (Lazzaro et al., 1998).

Clarke et al. (2001a) investigated differences between children with ADHD- com and ADHD- in. In most measures, the inattentive group was found to have EEG abnormalities that were similar to those found in children with ADHD- com, except that they were not as extreme.

Clarke et al. (2001b) found that both the theta/alpha and theta/beta ratios can differentiate between groups of normal children and children with ADHD.

A theta/beta ratio increase represents cortical hypoarousal (cortical slowing) which is an increase in slow frequency neural activity and decrease in fast frequency neural activity in the cortex. EEG studies of ADHD have commonly reported slowing of electrophysiological activity, particularly in the frontal region (Barry et al., 2003). Cortical slowing is considered to be a marker of dysfunction in the frontal region (Bradley and Golden, 2001) and evidence from a variety of brain imaging studies support that frontal cortex dysfunction may be present with ADHD.

A side from the findings for theta and the theta/beta ratio, results for other frequency bands such as beta and alpha have been more variable among children with ADHD. The findings for beta (indicative of heightened cortical arousal) activity have been less consistent, with several studies finding decreased beta activity in frontal and central regions (Chabot& Serfontein, 1996; Lazzaro et al., 1998; Clarke et al., 1998, 2001c) and others not (Janzen et al., 1995; Kuperman et al., 1996).

Similarly, studies have found mixed results for alpha power, with some studies showing it to be increased (Chabot& Serfontein, 1996; Clarke et al., 2001c), others showing it to be decreased (El- Sayed et al., 2002), and still other studies finding it to be similar (Bresnahan et al., 1999) between children with ADHD and normal controls. Gender and age may play a role in these discrepant findings, as well as differences in methods such as sampling (i. e., community vs. clinical samples), diagnostic procedures, and EEG data collection and processing.

Children with ADHD have also been found to have abnormal patterns of EEG activity when switching between tasks (Penberthy et al., 2005), as well as abnormal patterns of a desynchronisation when changing from an eyes- open to eyes- closed resting condition (Robeva et al., 2004).

Most research findings show that most children with ADHD display fairly consistent EEG differences in brain electrical activity when compared to normal children, particularly regarding frontal and central theta activity, which is associated with underarousal and indicative of decreased cortical activity (Chabot& Serfontein, 1996; Clarke et al., 1998, 2001c; El- Sayed et al., 2002).

Voeller (2004) also reported that EEG studies of children with ADHD indicated excessive slow wave theta activity associated with reduced alertness and hypoarousal. Generalized theta excess has been found in ADHD children in both the resting state and during cognitive activity (DeFrance et al., 1996).

Clarke et al. (2001c) found that children with ADHD had increased theta and deficiencies of alpha and beta activity. Cluster analysis identified 3 distinct EEG- defined subtypes. One cluster had increased total power, relative theta and theta/beta ratio, and decreased relative delta and beta across all regions, considered indicative of cortical hypoarousal. Another was characterized by increased slow wave and deficiencies of fast wave activity, indicating a maturational lag in CNS development, although their theta levels were slightly higher than expected, suggesting an additional dysfunction. The third cluster had excess beta activity, and was labelled an over- aroused group.

In several studies, more elaborate statistical analyses demonstrated that the fraction of DSM- IV ADHD subjects who did not show an increase in the theta/beta ratio instead showed an increase in frontal beta power (Clarke et al., 2002).

Aim Of The Study:

The study aimed to detect EEG differences among ADHD subtypes.

Patients and Methods:

This study was Descriptive Analytical study.

1. Patients: The study included 60 diagnosed ADHD children, recruited from the Pediatrics Psychiatric Clinic of Police Authority Hospital over a period of one year. Their age ranged from (5– 14) years, with a mean age 7.68 ± 2.21 years. They were 39 males and 21 females. Those children were divided according to DSM- IV criteria for childhood- onset ADHD (American Psychiatric Association, 1994) into 3 groups:
   - Group I (ADHD- In): It included 19 ADHD children; the children were fulfilling the criteria for the diagnosis of inattentive subtype of ADHD. Their ages ranged between (5- 14) years with a mean age (8.07± 2.64) years. They were 9 males and 10 females.
   - Group II (ADHD- HI): It included 23 ADHD children; the children were fulfilling the criteria for the diagnosis of hyperactive- impulsive subtype of ADHD. Their ages ranged between (5- 14) years with a mean age (7.17± 1.54) years. They were 18 males and 5 females.
   - Group III (ADHD- Com): It included 18 ADHD children; the children were fulfilling the criteria for the diagnosis of combined subtype of ADHD. Their ages ranged between from (5- 14) years with a mean age (7.91± 2.42) years. They were 12 males and 6 females.
   1. Inclusion Criteria:
      - Children diagnosed as ADHD.
      - Age range is from (5- 14) years.
      - Both sexes were included.
   2. Exclusion Criteria:
      - Neurological disorders(organic brain damage, CNS infections).
      - Long Term Medication.
      - Metal plate or metal device in the head.
2. Methods: The three studied groups were subjected to:
   - Complete Personal& Medical history taking: All children included in this study were subjected to full medical history taking, laying stress on developmental history (including information about pregnancy, birth

history, developmental milestone and speech development) and ADHD family history.

¤ Neuropsychiatric Assessment:

a. Clinical Psychiatric Interview: It was done with children and their parents according to psychiatric sheet of Pediatrics Psychiatric Clinic of Police Authority Hospital, which was prepared by Dr. Olweya Abd Elbaky Professor of Child& Adolescent Psychiatry- Institute of Postgraduate Childhood Studies, Ain Shams University.

b. Full Neurological Assessment: Clinical history and clinical examination were done to exclude any neurological disease.

c. ADHD Assessment: Assessment of core symptoms ADHD according to (DSM- IV) for diagnostic criteria of ADHD (American Psychiatric Association, 2000) and age of onset of these symptoms.

¤ Electroencephalographic (EEG) study:

a. Preparation of the child by degreasing the scalp by water and soap.

b. The machine: conventional Neurofax EEG recording machine.

¤ Preparation of the child by degreasing the area where the electrodes were to be mounted with a gauze pad moistened in alcohol or medical soap solution, then wiped the site with dry gauze to remove natural oils from the skin.

¤ The electrodes were placed in close contact with the skin, which had been prepared so as to lower its resistance. The electrode locations and names are specified by the International (10- 20) system (Towle et al., 1993). Each electrode was connected by means of a wire or electrode lead to the connection box. The wire can be soldered direct to the electrode or attached with a metal clip which ensures electrical contact with it. The other end had a plug which is inserted into the connection box at the number corresponding to the placement of the electrode. The connection box, also known as electrode panel of head board comprises 23 electrode input sockets, plus 2 earth ground terminals points. Thus, numerous rails which as on actual railways were permit selection of a particular route to be chosen. The selectors were placed between the electrodes and the amplifying channel. Each selector enabled the connection of any pair of electrodes to the input of the chosen channel, thus there were 23 positions. A pre- set montages or automatic programmer which gives a reduced number of montages from (8 -12). A group of amplifiers, filters and electrical energy stabilizing components were located between the input circuit and recording appliance.

¤ A galvanometer writer transformed variations in current at the output of the last stage of amplification into angular displacement of a pen mounted on a vertical axis, because of this writing is curvilinear. The duration of each variation of potential was measurable from the tracing on the paper whose speed is known and can be controlled: 15, 30 or 60 mm/sec.

Statistical Analysis:

Data collected were verified, revised, coded, tabulated and then edited on computer. Analysis of the obtained data was done using Statistical Package for Social Science (SPSS) program version 12.0 (SPSS, 2004).

Results:

Table (1) Age distribution between ADHD groups

		Core Symptoms Of ADHD			P	Sig.
		Inattention	Hyperactive- Impulsive	Combined		
Age	Total	19	23	18	0.697	NS
	Mean	8.07	7.17	7.91		
	±Sd	±2.64	±1.54	±2.42		

P is significant at the level<0.05

Table (1) shows that the mean of age in inattention group is 8.07± 2.64, in hyperactive- impulsive group is 7.17± 1.54 and in combined group is 7.91± 2.42, so there is no significant difference between different subtypes of ADHD regarding age distribution.

Table (2) Gender distribution among ADHD groups

		Core Symptoms Of ADHD			P	Sig.
		Inattention	Hyperactive- Impulsive	Combined		
Sex	Male	9	18	12	0.11	NS
	Female	10	5	6		

P is significant at the level<0.05

Table (2) shows no statistical significant differences between different groups of ADHD regarding sex.

Table (3) Comparison between different ADHD groups according to EEG- background activity

		Core Symptoms Of ADHD			P	Sig.
		Inattention	Hyperactive- mpulsive	Combined		
EEG- Background Activity	Rhythmic	6	6	2	0.31	NS
	Dysrhythmic	13	17	16		

P is significant at the level<0.05

Table (3) shows no statistical significant differences among different groups of ADHD as regarding EEG- background activity.

Table (4) Descriptive statistics of EEG changes in ADHD children:

Electrical Changes / Type Of Wave	No Changes		present		More Evident		High Evident	
	NO	%	NO	%	NO	%	NO	%
Rt Frontal Alpha Wave	8	13.3%	13	21.7%	32	53.3%	7	11.7%
Rt Frontal Beta Wave	23	38.3%	14	23.3%	19	31.7%	4	6.7%
Rt Frontal- Delta Wave	36	60.0%	20	33.3%	3	5.0%	1	1.7%
Rt Frontal- Theta Wave	41	68.3%	14	23.3%	5	8.3%	0	0.0%
Lt Frontal- Alpha Wave	5	8.3%	7	11.7%	28	46.7%	20	33.3%
Lt Frontal- Beta Wave	2	3.3%	25	41.7%	0	0.0%	33	55.0%
Lt Frontal- Delta Wave	3	5.0%	4	6.7%	41	68.3%	12	20.0%
Lt Frontal- Theta Wave	9	15.0%	9	15.0%	30	50.0%	12	20.0%
Rt Parietal- Alpha Wave	40	66.7%	2	3.3%	17	28.3%	1	1.7%
Rt Parietal- Beta Wave	38	63.3%	6	10.0%	14	23.3%	2	3.3%
Rt Parietal- Delta Wave	44	73.3%	14	23.3%	2	3.3%	0	0.0%
Rt Parietal- Theta Wave	41	68.3%	14	23.3%	5	8.3%	0	0.0%
Lt Parietal- Alpha Wave	40	66.7%	2	3.3%	15	25.0%	3	5.0%
Lt Parietal- Beta Wave	35	58.3%	9	15.0%	14	23.3%	2	3.3%
Lt Parietal- Delta Wave	42	70.0%	14	23.3%	4	6.7%	0	0.0%
Lt Parietal- Theta Wave	41	68.3%	13	21.7%	5	8.3%	1	1.7%
Rt Temporal- Alpha Wave	58	96.7%	0	0.0%	1	1.7%	1	1.7%
Rt Temporal- Beta Wave	25	41.7%	10	16.7%	19	31.7%	6	10.0%
Rt Temporal- Delta Wave	40	66.7%	14	23.3%	4	6.7%	2	3.3%
Rt Temporal- Theta Wave	28	46.7%	20	33.3%	8	13.3%	4	6.7%
Lt Temporal- Alpha Wave	56	93.3%	2	3.3%	1	1.7%	1	1.7%
Lt Temporal- Beta Wave	13	21.7%	31	51.7%	10	16.7%	6	10.0%
Lt Temporal- Delta Wave	31	51.7%	14	23.3%	7	11.7%	8	13.3%
Lt Temporal- Theta Wave	3	5.0%	12	20.0%	32	53.3%	13	21.7%

Electrical Changes / Type Of Wave	No Changes		present		More Evident		High Evident	
	NO	%	NO	%	NO	%	NO	%
Rt Occipital- Alpha Wave	5	8.3%	25	41.7%	25	41.7%	5	8.3%
Rt Occipital- Beta Wave	6	10.0%	13	21.7%	21	35.0%	20	33.3%
Rt Occipital- Delta Wave	11	18.3%	11	18.3%	33	55.0%	5	8.3%
Rt Occipital- Theta Wave	22	36.7%	32	53.3%	4	6.7%	2	3.3%
Lt Occipital- Alpha Wave	5	8.3%	4	6.7%	34	56.7%	17	28.3%
Lt Occipital- Beta Wave	3	5.0%	6	10.0%	27	45.0%	24	40.0%
Lt Occipital- Delta Wave	33	55.0%	23	38.3%	4	6.7%	0	0.0%
Lt Occipital- Theta Wave	38	63.3%	16	26.7%	5	8.3%	1	1.7%

Table (4) shows frequency of intensity of changes as regard the different EEG waves.

Table (5) Comparison between different ADHD types regarding different frontal waves

		Core Symptoms Of ADHD			P	Sig
		Inattention	Hyperactive- Impulsive	Combined		
RT Frontal- Alpha Wave	None	2	2	4	0.087	NS
	Present	4	2	7		
	More Evident	11	16	5		
	High Evident	2	3	2		
RT Frontal- Beta Wave	None	8	10	5	0.734	NS
	Present	4	4	6		
	More Evident	6	8	5		
	High Evident	1	1	2		
RT Frontal- Delta Wave	None	14	13	9	0.118	NS
	Present	5	9	6		
	More Evident	0	1	2		
	High Evident	0	0	1		
RT Frontal- Theta Wave	None	15	16	10	0.232	NS
	Present	3	6	5		
	More Evident	1	1	3		
	High Evident	0	0	0		
LT Frontal- Alpha Wave	None	0	2	3	0.041	S
	Present	4	0	3		
	More Evident	7	11	10		
	High Evident	8	10	2		
LT Frontal- Beta Wave	None	1	0	1	0.763	NS
	Present	0	0	0		
	More Evident	8	10	7		
	High Evident	10	13	10		
LT Frontal- Delta Wave	None	1	2	0	0.606	NS
	Present	2	0	2		
	More Evident	13	17	11		
	High Evident	3	4	5		
LT Frontal- Theta Wave	None	3	4	2	0.511	NS
	Present	5	1	3		
	More Evident	8	15	7		
	High Evident	3	3	6		

P is significant at the level <0.05

Table (5) shows significant difference among different ADHD subtypes as regarding intensity of Lt frontal alpha wave, but no significant difference among different ADHD subtypes as regarding intensity of other frontal waves.

Table (6) Comparison between different ADHD types regarding different parietal waves

		Core Symptoms Of ADHD			P	Sig
		Inattention	Hyperactive- Impulsive	Combined		
RT Parietal- Alpha Wave	None	12	16	12	0.928	NS
	Present	2	0	0		
	More Evident	5	7	5		
	High Evident	0	0	1		
RT Parietal- Beta Wave	None	14	16	8	0.336	NS
	Present	0	2	4		
	More Evident	5	4	5		
	High Evident	0	1	1		
RT Parietal- Delta Wave	None	15	16	13	0.600	NS
	Present	4	7	3		
	More Evident	0	0	2		
	High Evident	0	0	0		
RT Parietal- Theta Wave	None	15	16	13	0.253	NS
	Present	4	7	3		
	More Evident	0	0	2		
	High Evident	0	0	0		
LT Parietal- Alpha Wave	None	12	16	12	0.963	NS
	Present	2	0	0		
	More Evident	5	5	5		
	High Evident	0	2	1		
LT Parietal- Beta Wave	None	13	12	10	0.749	NS
	Present	1	5	3		
	More Evident	5	5	4		
	High Evident	0	1	1		
LT Parietal- Delta Wave	None	15	15	12	0.497	NS
	Present	3	8	3		
	More Evident	1	0	3		
	High Evident	0	0	0		
LT Parietal- Theta Wave	None	14	17	10	0.127	NS
	Present	4	5	4		
	More Evident	1	1	3		
	High Evident	0	0	1		

P is significant at the level <0.0 5

Table (6) shows no significant difference among different ADHD types as regarding intensity of different parietal waves.

Table (7) Comparison between different ADHD types regarding different temporal waves

		Core Symptoms Of ADHD			P	Sig
		Inattention	Hyperactive- Impulsive	Combined		
RT Temporal- Alpha Wave	None	19	21	18	0.210	NS
	Present	0	0	0		
	More Evident	0	1	0		
	High Evident	0	1	0		
RT Temporal- Beta Wave	None	11	8	6	0.197	NS
	Present	3	3	4		
	More Evident	4	9	6		
	High Evident	1	3	2		
RT Temporal- Delta Wave	None	14	15	11	0.619	NS
	Present	4	7	3		
	More Evident	0	0	4		
	High Evident	1	1	0		
RT Temporal- Theta Wave	None	12	10	6	0.378	NS
	Present	4	9	7		
	More Evident	2	2	4		
	High Evident	1	2	1		

		Core Symptoms Of ADHD			P	Sig
		Inattention	Hyperactive- Impulsive	Combined		
LT Temporal-Alpha Wave	None	18	21	17	0.463	NS
	Present	1	0	1		
	More Evident	0	1	0		
	High Evident	0	1	0		
LT Temporal-Beta Wave	None	5	5	3	0.675	NS
	Present	10	11	10		
	More Evident	3	4	3		
	High Evident	1	3	2		
LT Temporal-Delta Wave	None	12	11	8	0.521	NS
	Present	3	9	2		
	More Evident	1	0	6		
	High Evident	3	3	2		
LT Temporal-Theta Wave	None	2	1	0	0.865	NS
	Present	4	3	5		
	More Evident	7	17	8		
	High Evident	6	2	5		

P is significant at the level <0.0 5

Table (7) shows no significant difference among different ADHD types as regarding intensity of different temporal waves.

Table (8) Comparison between different ADHD types regarding different occipital waves

		Core Symptoms Of ADHD			P	Sig
		Inattention	Hyperactive- Impulsive	Combined		
RT Occipital Alpha Wave	None	1	2	2	0.838	NS
	Present	7	10	8		
	More Evident	10	10	5		
	High Evident	1	1	3		
RT Occipital Beta Wave	None	3	0	3	0.189	NS
	Present	3	4	6		
	More Evident	6	11	4		
	High Evident	7	8	5		
RT Occipital Delta Wave	None	1	5	5	0.701	NS
	Present	7	1	3		
	More Evident	9	16	8		
	High Evident	2	1	2		
RT Occipital Theta Wave	None	7	9	6	0.687	NS
	Present	11	12	9		
	More Evident	0	2	2		
	High Evident	1	0	1		
LT Occipital Alpha Wave	None	2	3	0	0.198	NS
	Present	3	0	1		
	More Evident	11	12	11		
	High Evident	3	8	6		
LT Occipital Beta Wave	None	1	1	1	0.466	NS
	Present	0	1	5		
	More Evident	11	11	5		
	High Evident	7	10	7		
LT Occipital Delta Wave	None	13	10	10	0.452	NS
	Present	5	13	5		
	More Evident	1	0	3		
	High Evident	0	0	0		
LT Occipital Theta Wave	None	12	17	9	0.188	NS
	Present	5	5	6		
	More Evident	2	1	2		
	High Evident	0	0	1		

P is significant at the level <0.0 5

Table (8) shows no significant difference among ADHD types as regarding intensity of different occipital waves.

Discussion:

ADHD is a neurobiological syndrome with an estimated prevalence among children and adolescents of 5% (Millichap, 2008).

ADHD is a chronic early- onset syndrome of developmentally inappropriate levels of in attention, hyperactivity, and impulsivity (American Psychiatric Association, 1994). Core symptoms are often clearly evident in overt disruptive behavior and Learning problems in children with ADHD, with persisting symptoms typically display cognitive and behavioral impairments which, nonetheless, are often associated with significant educational, occupational, interpersonal emotional, and even legal difficulties (Mannuzza et al., 2003).

Although ADHD is currently a behaviourally driven diagnosis, it is considered to result from a CNS dysfunction, and EEG provides a direct measure of brain functioning, it appears to be an appropriate tool for assessing this disorder.

It was observed in the present sample that ADHD was more prevalent in boys than girls with male to female ratio (1.9: 1). This is in accordance with most recent studies of ADHD all over the world that found male to female ratio was 2.5: 1 (Centers for Disease Control and Prevention, 2010) or 2.28:1 (Ramtekkar et al., 2010). Also other studies estimated that greater than 75% of ADHD diagnoses are made in males (Schneider& Eisenberg, 2006: Pastor& Reuben, 2008).

The gender discrepancy appears to be subtype- specific: inattentive ADHD is most prevalent amongst girls (Biederman et al., 2002), whereas hyperactive-impulsive and combined subtypes are thought to be more common in boys (Adler et al., 2008). Thus, sex differences in presentation of the disorder may feasibly account for sex- specific differences in referrals and diagnosis (Biederman et al., 2002; Lahey et al., 1994), these finding are coinciding with those of the present study.

Moreover, Faraone et al., (2000) explained that gender difference was due to the presence of inattentive form of the disorder in girls, thus they might pass undetected and remain silent cases.

El- Tallawy et al., (2005) referred to two previous studies explaining gender difference. The first study was Brut, (1950) who reported that the slightly larger heads of males might have rendered them more susceptible to pressure and head injury at birth thus leading to ADHD development. The second study was that of Tanner, (1961) who stated that skeletal immaturity of boys relative to girls rendered boys more vulnerable to damage and that led to minimal brain damage which predisposed later on to development of ADHD among those children.

Electroencephalographic (EEG) recording provides a non- invasive measure of baseline brain activity. Such baseline or 'tonic' activity is considered to be an index of the underlying brain state, prior to its activation during specific information processing (Barry et al., 2003). It has been reported that EEG measures have a high degree of sensitivity in distinguishing ADHD from healthy control subjects (Chabot and Serfontein, 1996; Monastra et al., 2001).

However, the use of EEG in ADHD diagnosis has been criticized on the basis of poor sensitivity and specificity (Levy and Ward, 1995). Numerous studies measuring EEG during a 'resting state' (i. e. during eyes open or closed conditions) have observed a consistent elevation in low frequency activity, particularly theta (4-7 Hz), in ADHD subjects compared with healthy controls (Barry et al., 2003). Some key models have been proposed to interpret EEG changes in ADHD.

The 'Maturational Lag' model states that ADHD children have neurodevelopmental profiles representative of healthy children at younger ages (Kinsbourne, 1973). From this model, raised EEG theta activity is interpreted as evidence of delayed cortical maturation. An alternative to this model, the 'Develop- Developmental Deviation' model, proposes that ADHD is a deviation (rather than lag) from normal brain stability, and is not comparable to normal brain profiles at any age (Chabot and Serfontein, 1996).

The present study revealed that 47% of all ADHD groups showed electroencephalographic changes. This is in agreement with Clark et al., (2001d) who reported that 45%- 90% of ADHD children show electroencephalographic abnormalities. Barry et al., (2003) reported that electroencephalographic measurements have been regarded as highly sensitive in distinguishing ADHD patients from healthy subjects.

In the results of the present study there were significant differences between ADHD types regarding intensity of Lt frontal alpha wave, which was significantly increased in combined ADHD group more than in inattention and hyperactive- impulsive ADHD groups, but there were no significant differences between ADHD groups regarding intensity of other EEG waves.

Hyperactivity and the executive control of behavior in ADHD has been predominantly linked to frontal lobe functioning, whereas inattention in ADHD has been linked to the frontal lobes as well as to right parietal and midline subcortical regions involved in the regulation of attention and arousal (Booth et al., 2007).

Also this is in agreement with Barry et al., (2007) who found correlation between alpha activity and attention defects has been shown in go/no go out of task. The alpha activity level reflects a certain arousal state. The results of Shi et al., (2012) study showed that the level of alpha activities and full scale attention quotient share a significant positive correlation, implying that the alpha level affects brain resource allocation.

On the other hand Hermens et al., (2005) found that the ADHD- com subtype showed increased beta compared to the ADHD- in subtype, these differences were apparent in both males and females, and differed only in terms of topography: ADHD- com males showed increases frontally, whereas ADHD- com females showed increased activity at centro- posterior sites. This difference is in line with the general decrease in posterior beta activity for ADHD females, regardless of subtype.

In Clarke et al. (2001d), the question of whether the same type of inattention is found in the ADHD- com and ADHD- in subtypes of ADHD was raised. Behavioural studies have suggested that the inattention in the inattentive subtype may be a different form of impairment to that in the combined subtype (Barkley et al., 1990; Lahey and Carlson, 1992). Inattentive ADHD children are often dreamy, hypoactive, and passive (Barkley et al., 1990; Lahey and Carlson, 1992), while children with the combined subtype of ADHD have a problem of sustained attention and are easily distracted (Barkley, 1997). Clarke et al. (2001d) found distinct EEG differences in the frontal regions which were associated with the hyperactive/ inattentive symptoms.

While in Clarke et al., (1998) significant differences across all regions were found between patient groups in the relative theta and alpha bands. ADHD-com subjects had a greater percentage of theta than ADHD- in subjects for all regions. In the alpha band, the reverse was found, with the ADHD- in subjects having greater alpha than the ADHD- com subjects. A similar finding for relative delta in posterior regions was noted. ADHD- com subjects had a greater percentage of delta than the ADHD- in subjects.

Clarke et al., (1998) demonstrated the existence of measurable differences between children with ADHD- com and ADHD- in. These differences appear to be in the degree of severity of the differences from the control group, rather than in the nature of the EEG abnormalities, suggesting that these two subgroups of ADHD are not neurologically independent. This is compatible with the results of Chabot and Serfontein (1996).

The principal difference in the diagnosis of the two subtypes of ADHD involves behavioural aspects. Children with ADHD- com are often restless and fidgety, are impulsive, have a short concentration span and are easily distracted. Children with ADHD- in have the concentration problems but do not have the gross behavioural aspects of ADHD- com (Clarke et al., 1998).

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