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Correlation between Hemispherectomy and Hemiparesis in Drug Resistant Epilepsy

Al Khateeb Mashael, MD[1], Haris Maryam[2], Razack Raidah Ayesha[2]

[1]Department of Neurosciences, King Faisal Specialist Hospital and Research Center, Riyadh; [2]Alfaisal University, College of Medicine, Riyadh, Saudi Arabia

Background and Purpose: Refractory epilepsy is when seizures are unresponsive to two or more medications. Hemispherectomy, one of the treatment options, is the complete removal or functional disconnection of a cerebral hemisphere. Hemiparesis, a symptom of epilepsy, is defined as weakness of one side of the body. Patients with refractory epilepsy, who experience extreme seizure frequency, are subjected to hemispherectomy. This study focuses on finding the correlation between hemispherectomy and hemiparesis, discovering a pattern in its severity levels before and after surgery.

Methods: Data was collected from 59 epileptic patients suffering from refractory epilepsy, who underwent hemispherectomy, at the King Faisal Specialist Hospital and Research Centre, from 1998 to 2014. Each patient was monitored over a period of 1-year post-surgery. In this study, we wanted to further explore the correlation between hemispherectomy and hemiparesis.

Results: Upon analyzing the sample size, the level of hemiparesis pre and post hemispherectomy remained the same for 32 patients, of which 13 patients had mild levels pre-surgery and 19 patients had moderate to severe levels pre-surgery. However, 20 of the patients who had moderate to severe levels of hemiparesis before the surgery had either no hemiparesis or a mild level after surgery, which signified an improvement in their severity level. On the other hand, seven of the patients went from having no hemiparesis before the surgery to having moderate or severe levels of hemiparesis post-surgery. Although the results were clinically significant, they were not statistically significant as the *p*-value obtained was 0.31.

Conclusions: After analyzing the results, it can be concluded that hemispherectomy does decrease the severity of hemiparesis in an epileptic patient, thereby improving his/her quality of life drastically. **(2021;11:32-38)**

Key words: Hemispherectomy, Paresis, Epilepsy, Drug resistance, Seizures

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Corresponding author:
Al Khateeb Mashael, MD
Department of Neurosciences, King Faisal Specialist Hospital and Research Center, Makkah Al Mukarramah Branch Rd, Al Mathar Ash Shamali, Riyadh 11211, Saudi Arabia
Tel. +966 50 777 4287
Fax. +966 11 4647272
E-mail; dr.alkhateebm@gmail.com

Introduction

Functional outcome

Epilepsy, affecting approximately 50 million people worldwide, is a neurological disorder, in which abnormal brain activity leads to seizures or unusual behavior, sensations and loss of awareness.[1] Our study focuses on drug resistant epilepsy, a subtype of epilepsy in which the seizures do not successfully respond to two or more antiseizure drug therapy. The International League against Epilepsy has defined refractory epilepsy as "failure of adequate trials of two tolerated, appropriately chosen and used antiepileptic drug schedules (whether as monotherapy or in combination) to achieve sustained seizure freedom." Almost 20-40% of epileptic patients are affected by drug-resistant epilepsy, also known as refractory epilepsy.[2]

The study of hemispherectomy surgery outcome is made difficult since it is not a common procedure. Nearly all published data are retrospective single-center experiences.[3] When medical therapy fails, surgery is often chosen and hemispherectomy is one of the exclusive treatment options for medically refractory epilepsy, which refers to the complete removal or functional disconnection of a cerebral hemisphere.[4] There are two types of hemispherectomy. The first one is anatomic hemispherectomy that involves the removal of larger parts of the brain like the frontal, parietal, temporal and the occipital lobes, while preserving the deeper structures like the basal ganglia

and the brain stem. This type of hemispherectomy, however, increases the risk of complications drastically. The second type is functional hemispherectomy which involves the removal of smaller areas of the affected hemisphere and the disconnection of the rest of the brain tissue by splitting the corpus callosum.[5] This type tends to lower the risk of complications and has shown to reduce the risk of seizures in 83% of the adult's post-surgery.

Hemiparesis, commonly seen in patients with refractory epilepsy, is defined as a mild to moderate degree of muscular weakness on any one side of the body.[6] Hemiplegia is a more severe form of hemiparesis, which involves complete loss of motor function on one side of the body. Based on several studies, it has been noted that children's cognitive abilities along with their motor competence are affected by hemiparesis, which ultimately has a negative influence on their everyday movement as their functional use of arms and legs is limited.[7] However, it has been observed and studied that the condition of individuals after hemispherectomy was changed from being completely dependent on others to being able to thrive on their own in a period of 5 years after the surgery. Furthermore, although low, their cognitive abilities seemed to be getting normal as well.[8]

Methods

Fifty-nine refractory epileptic patients who underwent hemispherectomy from 1998 to 2014 at King Faisal Specialist Hospital and Research Centre were analyzed. For each patient, the gender, current age, age at which surgery was performed, site of surgery, pre- and post-surgery hemiparesis level and side, physiotherapy and magnetic resonance imaging (MRI) abnormalities seen after surgery were collected. Each patient was then monitored over a period of 1-year post surgery. The severity level of each patient's hemiparesis was then assessed and categorized into none, mild, moderate, and severe, which were denoted by the numbers 0, 1, 2, and 3, respectively. Each severity level was defined as follows: none, when the patient showed no sign of muscle weakness on examination; mild, when the patient was not able to move their muscles against resistance; moderate, when the patient was not able to move their muscles against gravity; severe, when the patient was not able to move their muscles at all.

Results

Gender (Fig. 1)

Data was collected from 59 patients who underwent hemispherectomy in King Faisal Specialist Hospital and Research Center. Twenty-four out of 59 patients were male patients and 35 were female as depicted in the table above.

Age at surgery (Fig. 2)

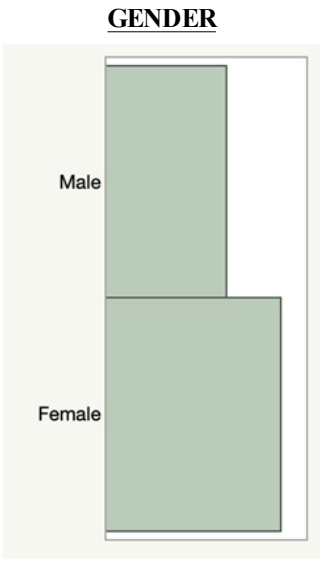
Majority of the patients who underwent the surgery were age 15 or below. Hemispherectomy was not performed for anyone above the age of 35.

Site of surgery (Fig. 3)

This graph shows that 26 out of 59 patients underwent hemispherectomy on the right hemisphere of their brain and 33 patients on the left hemisphere of their brain.

Pre-surgery hemiparesis scale (Fig. 4)

Eighteen patients had mild levels of hemiparesis pre surgery, 15 patients had moderate levels of hemiparesis, and 24 patients had severe hemiparesis before surgery. There were two patients who did not have hemiparesis before the surgery.



Level	Count	Probability
Female	35	0.59322
Male	24	0.40678
Total	59	1.00000

Figure 1. Gender of the patients who underwent hemispherectomy. It's a bar graph showing the number of male and female patients in the sample size that was taken.

Pre-surgery hemiparesis site (Table 1)

This table shows the site of hemiparesis before the patients underwent hemispherectomy. Thirty out of 59 patients had hemiparesis on their right side and 27 patients suffered from left sided hemiparesis.

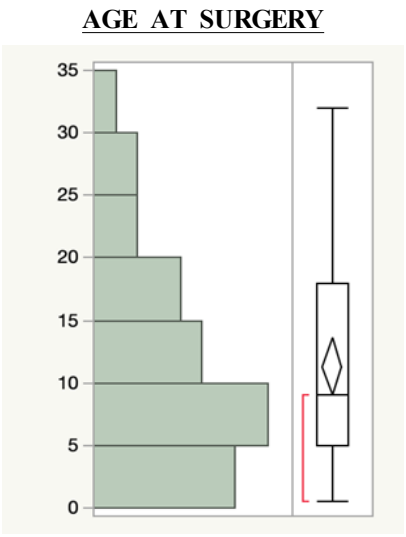
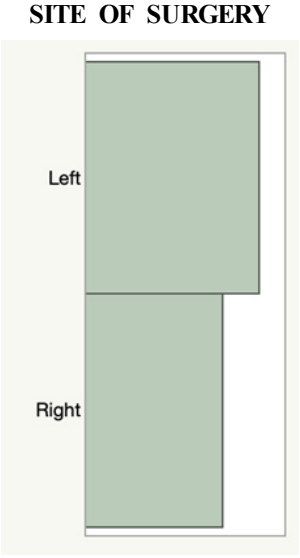


Figure 2. Age of patients at the time of surgery. The bar graph shown above depicts the age of all the patients at the time of the surgery (hemispherectomy). Most patients were seen to be pediatric patients.



Level	Count	Probability
Right	26	0.44068
Left	33	0.55932
Total	59	1.00000

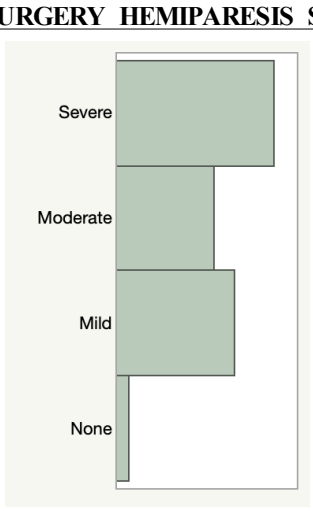
Figure 3. Site of surgery. The bar graph shown in Figure 3 shows whether the surgery was done on either the left or the right hemisphere of the brain.

Post-surgery hemiparesis scale (Fig. 5)

According to this graph, 13 out of 59 patients have no hemiparesis after surgery and 20 patients have mild hemiparesis post-surgery. Moreover, 17 patients have moderate levels of hemiparesis and the nine remaining patients still have severe hemiparesis even after undergoing surgery.

Post-surgery hemiparesis site (Table 2)

Table 2 shows that there are 13 out of 59 patients with no hemiparesis after surgery. Out of the rest of the 46 patients, 13 patients are suffering from right sided hemiparesis and the other 13 are suffering from left sided hemiparesis.



Level	Count	Probability
None	2	0.03390
Mild	18	0.30508
Moderate	15	0.25424
Severe	24	0.40678
Total	59	1.00000

Figure 4. Pre-surgery hemiparesis scale. This bar graph shows the severity of hemiparesis (one sided paralysis of the body) before the surgery amongst the patients.

Table 1. Pre-surgery hemiparesis site

Level	Count	Probability
None	2	0.03390
Right	30	0.50847
Left	27	0.45763
Total	59	1.00000

Physiotherapy after surgery (Table 3)

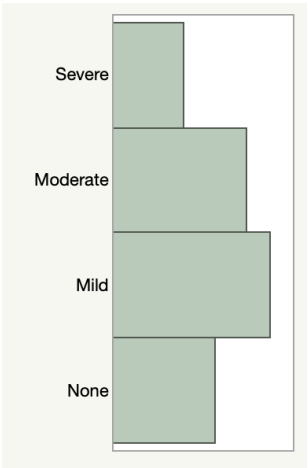
According to this data, almost half of the patients (29 patients) underwent physiotherapy after the surgery and the rest (30 patients) did not.

MRI abnormalities after surgery (Table 4)

Table 4 shows that 30 out of 59 patients had normal MRI after surgery, whereas 29 patients were found to have abnormalities in their MRIs.

Site of MRI abnormalities (Table 5)

Out of 29 patients who had MRI abnormalities, 14 patients had abnormalities on the right hemisphere of their brain and 15 on the left hemisphere of their brain.



Level	Count	Probability
None	13	0.22034
Mild	20	0.33898
Moderate	17	0.28814
Severe	9	0.15254
Total	59	1.00000

Figure 5. Post-surgery hemiparesis scale. The graph above shows the level of hemiparesis seen in patients after the surgery. It depicts how many patients got worse and how many got better post-surgery.

Table 2. Post surgery hemiparesis site

Level	Count	Probability
None	13	0.22034
Right	23	0.38983
Left	23	0.38983
Total	59	1.00000

Table 3. Physiotherapy after surgery

Level	Count	Probability
No	30	0.50847
Yes	29	0.49153
Total	59	1.00000

Table 4. Magnetic resonance imaging abnormalities after surgery

Level	Count	Probability
Normal	30	0.50847
Abnormal	29	0.49153
Total	59	1.00000

Table 5. Site of magnetic resonance imaging abnormalities

Level	Count	Probability
None	30	0.50847
Right	14	0.23729
Left	15	0.25424
Total	59	1.00000

Logistic Fit of pre-surgery hemiparesis (Scale)
By Age of surgery

Model	-Loglikelihood	DF	Chi-square	Prob>ChiSq
Difference	0.668356	1	1.336711	0.2476
Full	67.143808			
Reduced	67.812163			

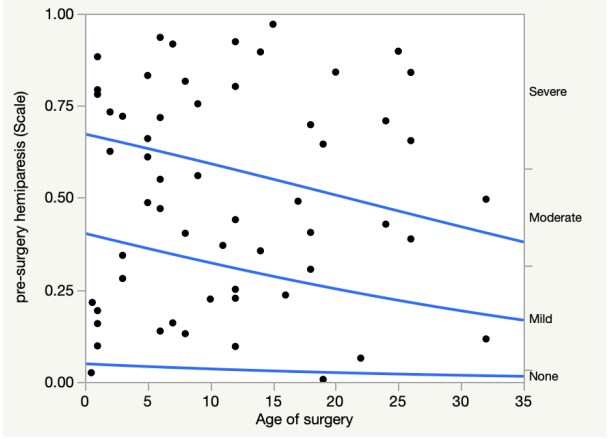
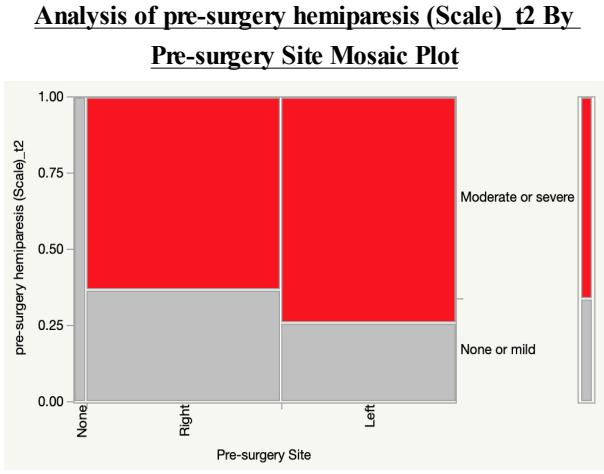


Figure 6. Correlation between the pre surgery hemiparesis scale and age of patients at the time of surgery. The figure above shows a scatter plot with negative correlation between the two variables. As the age of the patients decreases the level of hemiparesis increases. DF, degrees of freedom.



Count	None or mild	Moderate or severe	Total
None	2	0	2
Total (%)	3.39	0.00	3.39
Col (%)	10.00	0.00	
Row (%)	100.00	0.00	
Right	11	19	30
Total (%)	18.64	32.2	50.85
Col (%)	55.00	48.72	
Row (%)	36.67	63.33	
Left	7	20	27
Total (%)	11.86	33.90	45.76
Col (%)	35.00	51.28	
Row (%)	25.93	74.07	
Total	20 (33.90)	39 (66.10)	59

Test	Chi-square	Prob>ChiSq
Likelihood ratio	5.230	0.0732
Pearson	4.768	0.0922

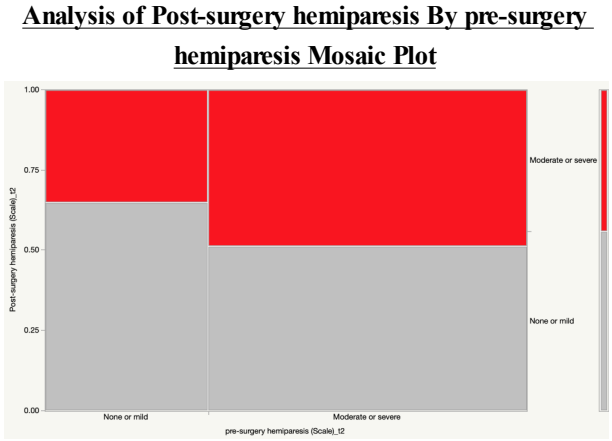
Figure 7. Correlation between pre-surgery hemiparesis scale and pre-surgery surgical site.

Logistic fit of pre-surgery hemiparesis (scale) by age of surgery (Fig. 6)

The younger patients had more severe hemiparesis levels pre surgery than the older patients. The data was not found to be statistically significant because the *p*-value came out to be 0.24.

Analysis of pre-surgery hemiparesis (scale) t2 by pre-surgery site mosaic plot (Fig. 7)

According to the graph, there were 18 patients with mild hemiparesis pre surgery, 11 of these patients were suffering from hemiparesis on the right side of their body, whereas the rest had left sided hemiparesis. On the other hand, there were 39 patients with moderate to severe hemiparesis pre surgery, 19 of those patients had right sided hemiparesis and 20 of them were suffering from left sided hemiparesis. The *p*-value for this came out to be 0.0922 according to the Pearson scale, which shows that there is no statistical significance between the pre surgery hemiparesis scale and the site of surgery.



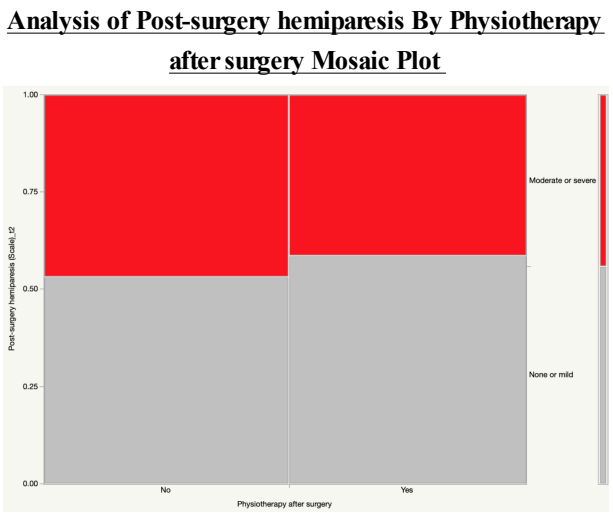
Count	None or mild	Moderate or severe	Total
None or mild	13	7	20
Row (%)	65.00	35.00	
Moderate or severe	20	19	39
Row (%)	51.28	48.72	
Total	33	26	59

Test	Chi-square	Prob>ChiSq
Likelihood ratio	1.021	0.3122
Pearson	1.009	0.3151

Figure 8. Analysis of post-surgery hemiparesis by pre-surgery hemiparesis. The mosaic plot shows the severity of hemiparesis pre surgery compared to how the levels got better or worse after the surgery.

Analysis of post-surgery hemiparesis by pre-surgery hemiparesis mosaic plot (Fig. 8)

Out of the 59 patients who underwent hemispherectomy, 13 had either no hemiparesis or mild levels of hemiparesis before surgery and their levels of hemiparesis remained the same post-surgery. Moreover, there were 20 patients who had moderate to severe levels of hemiparesis before surgery, but on examination after surgery, they were found to have either no hemiparesis or very mild level of hemiparesis. Seven patients went from no hemiparesis before surgery to moderate or severe levels of hemiparesis post-surgery.



Count	None or mild	Moderate or severe	Total
No	16	14	30
Total (%)	27.12	23.73	50.85
Col (%)	48.48	53.85	
Row (%)	53.33	46.67	
Yes	17	12	29
Total (%)	28.81	20.34	49.15 hy
Col (%)	51.52	46.15	
Row (%)	58.62	41.38	
Total	33 (55.93)	26 (44.07)	59

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	0.167	0.6825
Pearson	0.167	0.6826

Figure 9. Analysis of post-surgery hemiparesis by physiotherapy after surgery. The mosaic plot above shows the correlation between the severity of hemiparesis seen in patients after the surgery and how physiotherapy (if they got any) helped with the level of hemiparesis.

Nineteen remaining patients had moderate to severe levels of hemiparesis before surgery, which remained the same even after surgery. The *p*-value that we obtained was 0.31, which shows no statistical significance as the *p*-value is more than 0.05.

Analysis of post-surgery hemiparesis by physiotherapy after surgery mosaic plot (Fig. 9)

Out of the 59 patients, 16 had very mild or no hemiparesis after surgery, without undergoing any physiotherapy, whereas 17 who ended up having mild hemiparesis after surgery did undergo physiotherapy post-surgery. Twenty-six patients had moderate to severe levels of hemiparesis post-surgery, out of which 14 did not get any physiotherapy after surgery, whereas the rest did get physiotherapy. The data is not statistically significant because the *p*-value came out to be 0.0826 according to the Pearson scale which is greater than 0.05.

Discussion

In spite of enhancements in wellbeing and adequacy in epilepsy surgery, there are as yet noteworthy difficulties and treatment complications. Without a doubt, there will be proceeded with refinement of procedures with better results of seizure outcome and less complexities. There might be more opportunities to get better concerning the improvement of patient choice. A few if not most hemispherectomy failures are due to new or persistent seizures emerging from the contralateral side. As the capacity to recognize the extents and limits of epileptogenic tissue, more focused treatments can be used. In this manner, a few candidate patients for hemispherectomy might be better treated in the future with non-invasive procedures with minimum loss.[3]

Hemispherectomy surgery has progressed dramatically in the last ten years, while practiced routinely at major epilepsy centers around the world. At our study, we confirmed that hemispherectomy does decrease the severity of hemiparesis in an epileptic patient, thereby improving his or her quality of life drastically.

Conflict of Interest

The authors declare that they have no conflicts of interest.

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