

Magnetic resonance imaging findings in patients with cerebral palsy in Duhok, Iraq: Case series

Duhok, Irak'taki serebral palsili hastaların manyetik rezonans görüntüleme bulguları: Olgu serisi

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Abstract

Aim: Magnetic resonance imaging is an important technique for evaluating structural abnormalities in the brain. Many neurologists and pediatricians refer cerebral palsy patients to conventional magnetic resonance imaging. The objective of this study was to assess magnetic resonance imaging findings in children with cerebral palsy and to research whether it can predict the etiology or pathogenesis of this disease.

Methods: This case study was carried out at Azadi General Hospital from the 1st of July 2016 until the 28th of February 2017. A total of 48 patients who were diagnosed with cerebral palsy were included in the study. They all underwent cranial magnetic resonance imaging under general anesthesia, and results were compared statistically.

Results: The male to female ratio was 2.4:1. Magnetic resonance imaging was abnormal in 87.5%. Diffuse encephalopathy was seen in 56.2% of cases, periventricular leukomalacia was detected in 18.8%, changes of ischemic lesion were seen in 4.2 %, congenital malformations in 8.3% and normal scan was seen in 12.5% of cases. Among the clinical sub-types of cerebral palsy, spastic diplegia was the most common (47.9%), followed by spastic quadriplegia (35.4%), spastic hemiplegia (10.4%), and choreoathetoid cerebral palsy (6.3%).

Conclusions: This study concluded that brain changes in magnetic resonance imaging can detect the pathogenesis of cerebral palsy and is diagnostic in congenital brain malformations.

Keywords: Magnetic resonance imaging, Cerebral palsy

Öz

Amaç: Manyetik rezonans görüntüleme beyindeki yapısal anormallikleri değerlendirmek için önemli bir tekniktir. Birçok nörolog ve çocuk doktoru serebral palsi hastalarını konvansiyonel manyetik rezonans görüntülemeye yönlendirir. Bu çalışmanın amacı serebral palsili çocuklarda manyetik rezonans görüntüleme bulgularını değerlendirmek ve bu hastalığın etiyolojisini veya patogenezini öngörüp öngöremeyeceğini araştırmaktır.

Yöntemler: Bu vaka çalışması 1 Temmuz 2016 - 28 Şubat 2017 tarihleri arasında Azadi Genel Hastanesi'nde gerçekleştirildi. Serebral palsi tanısı alan toplam 48 hasta çalışmaya dahil edildi. Hepsine genel anestezi altında kraniyal manyetik rezonans görüntüleme yapıldı ve sonuçlar istatistiksel olarak karşılaştırıldı.

Bulgular: Erkek/kız oranı 2,4:1 idi. Manyetik rezonans görüntüleme hastaların %87,5'inde anormaldi. Olguların %56,2'sinde diffüz ensefalopati, %18,8'inde periventriküler lökolazi, %4,2'sinde iskemik lezyon değişiklikleri, %8,3'ünde konjenital malformasyon ve %12,5'inde normal tarama saptandı. Serebral palsi klinik alt tipleri arasında en yaygın spastik dipleji (%47,9), ardından spastik quadripleji (%35,4), spastik hemipleji (%10,4) ve koreoetotoid serebral palsi (%6,3) gözlemlendi.

Sonuç: Bu çalışma manyetik rezonans görüntüleme beyin değişikliklerinin serebral palsi patogenezini tespit edebildiği ve konjenital beyin malformasyonlarında tanısız olduğu sonucuna varmıştır.

Anahtar kelimeler: Manyetik rezonans görüntüleme, Serebral palsi

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Introduction

Cerebral Palsy (CP) occurs due to a defect or lesion in the developing brain, which may have had its onset in the prenatal, perinatal, or postnatal period [1]. It is important to know the onset of the brain injury, as it is significant in the assessment of recurrence risk and the implementation of prevention programs [2].

Two large meta-analyses have attempted to document the extent and spectrum of central nervous system abnormalities found on Magnetic Resonance Imaging (MRI) in children with CP. Ashwal et al. [3], who studied data involving 644 children with CP, and found abnormal MRI in 89%, concluded that neuro-pathologic changes seen in MRI can be linked to the gestational ages of the infant at the time of brain injury.

In Ashwal et al.'s [3] study, periventricular leukomalacia (PVL) was the commonest MRI abnormality in preterm patients, while diffuse encephalopathy (cortical/subcortical atrophy/ventriculomegaly) was mostly detected in term infants. The second meta-analysis conducted by Krägeloh-Mann and Horber [4], who found 86% of the patients showed abnormal MRI findings, concluded that PVL was mostly seen in the early third trimester and the prematurely born infant, while cortical and subcortical atrophy, damage to the basal ganglia and thalamus were more commonly observed towards the end of the third trimester, during the perinatal period and in the term infant. In another study carried out at Al-Kindy Teaching hospital, 91 CP cases underwent computerized tomography (CT) scans, among which cortical and subcortical brain atrophy were the commonest findings [5].

An important point is that an abnormality on MRI does not necessarily mean that the etiology of the motor deficit has been established. For example, diffuse cortical atrophy and delayed myelination are non-specific findings which only suggest that a CNS disturbance occurred and may not reveal the underlying cause [3].

The present study aims to assess the cranial MRI findings in children with CP in terms of abnormalities and pathogenesis and compare them along with the demographic data and subtypes of disease.

Materials and methods

This case study was approved by the Scientific Research Committee of the Faculty of Medicine and the Ethics Committee of the Directorate of Health. Oral and written consent forms were obtained from parents of all patients.

The study was conducted at the radiology department/MRI unit in Azadi general hospital in Duhok governorate over a period of 8 months, between 01/07/2016 and 28/02/2017.

This study included 48 children younger than 5 years of age, referred by either the Pediatrician or the neurologist from the Early Detection and Rehabilitation center. All children were clinically diagnosed CP patients whose physician asked for MRI scans. Children older than 5 years of age with determined CP etiologies and those not fit to receive general anesthesia were excluded.

History regarding gestational age was obtained from the patients' patients, after which all patients were categorized into three groups as Preterm (born before 37 gestational weeks), Term (born between the 37th and 42nd gestational weeks) and Post-term (born after the 42nd gestational week). History of any maternal diseases during pregnancy was reported, including hypertension, heart diseases, blood incompatibility disorders and others like diabetes mellitus. Any admission to neonatal care unit for asphyxia and or convulsion was recorded. The CP clinical sub types (i.e. topographic distribution of motor involvement) were reported by the referred physician and categorized as spastic or non-spastic. Types of spastic CP included diplegic, quadriplegic, or hemiplegic CP while non-spastic CP comprised the chorea athetotic type.

Parents were informed to keep their children fasted for 4 hours as directed by the anesthesiologist. In the radiology department, all patients were examined by the anesthesiologist, who was responsible for administration of general anesthesia, along with his/her assistant. The cranial diffusion weighted MRI was obtained using the 1.5 Tesla Philips machine.

The axial diffusion weighted sections used the following parameters: TR 5067ms repetition time, TE 156ms echo time, 23 cm field-of-view, -10° flip angle, 152x105 acquisition matrix. 20 contiguous slices of about 5 mm thickness were interpreted. T1W was obtained with TR 596 ms, TE 15ms, T2W with TR 4855ms, TE 110ms and FLAIR with TR 6000ms, TE 120ms.

Coronal, axial and sagittal views were examined. The child remained still over a period of 10 to 15 minutes. Findings obtained on the MRI were classified into 6 patterns of abnormality as defined and described by Ashwal et al. [3], as follows: Normal: No abnormality detected on MRI. PVL: Signal abnormality and/or volume loss in the periventricular and/or deep white matter, may include scalloping of the ventricles, ventricular dilatation, or periventricular cysts. Diffuse encephalopathy: Global/diffuse signal abnormality and/or volume loss involving the cortex/sub cortex, deep grey matter (basal ganglia and/or thalamus), and white matter/multicystic encephalomalacia. Focal ischemic or hemorrhagic lesions: Signal change, volume loss, or porencephaly in an established vascular territory with or without other focal ischemic or hemorrhagic lesions. Brain malformations: Cortical dysplasia, polymicrogyria, lissencephaly, pachygyria, heterotopias, schizencephaly, polymicrogyria, cerebellar hypoplasia or dysgenesis, holoprosencephaly, and hydranencephaly. Unclassified group: Any MRI abnormality that is unable to be classified into one of the above groups.

Statistical analysis

Collected data were entered into an Excel 2013 workbook and then converted into SPSS version 24 for analysis.

Results

The total number of patients was 48, 70.8% of total patients were males and the male to female ratio was 2.4:1. The mean age was 1.8 years. About 22.9% of patients in the study were preterm while 77.1% were term and post-term. The demographic characteristics of all patients are presented in Table 1. The most common clinical subtype of CP was spastic diplegia

(47.9%), followed by spastic quadriplegia (35.4%), hemiplegic CP (10.4%), and chorea-athetotic CP (6.3%).

Among all patients, 62.5% had no risk factors in contrast to 37.5% who did. Prematurity was the commonest risk factor in the study group, accounting for 32.2% of all risk factors, followed by prenatal maternal diseases (29.4%). Maternal hypertension was the commonest maternal disease. Perinatal asphyxia contributed to 23.5%, followed by twin gestation (8.8%) and neonatal hyperbilirubinemia, which constituted about 6% of all risk factors.

Abnormal MRI was detected in 87.5% of cases, diffuse encephalopathy was the commonest pattern observed (56.2%). PVL was observed in 18.75%, congenital brain malformation was seen in 8.33% and ischemic brain injury was detected in 4.16%. The remaining 12.5% had unremarkable brain MRIs. The MRI pattern differences between the preterm and full-term infants are presented in Table 2. All preterm patients had abnormal MRI findings. About 45.5% of preterm infants showed PVL. Ischemic causes were more common in preterm infants than term ones.

In term and post-term children, the most common MRI finding was diffuse encephalopathy, which was seen in the form of cortical and sub-cortical atrophy, and multicystic encephalomalacia. All patients with congenital malformations and those with normal MRIs were in the term and post-term groups.

The MRI findings according to the clinical subtypes of CP are presented in Table 3. Diffuse encephalopathy was seen in the MRI scan in 52% of patients with spastic diplegia, and 30.4% showed PVL. A relatively large percent of patients with spastic quadriplegia (64.7%) and 60% of patients with hemiplegia showed diffuse encephalopathy.

Table 1: Demographic characteristics of all patients

	n	%	
Age (years)	< 1 year	7	14.6
	1 - 3 years	31	64.6
	3 - 5 years	10	20.8
Gender	Male	34	70.8
	Female	14	29.2
Gestational age	Preterm	11	22.9
	Term and Post-term	37	77.1
Type of CP	Spastic diplegia	23	47.9
	Spastic quadriplegia	17	35.4
	Hemiplegia	5	10.4
	Chore-athetosis	3	6.3
Total	48	100	

Table 2: The distribution of CP patients according to MRI findings and gestational age at delivery

Gestational age at delivery	Normal	PVL	Diffuse encephalopathy	Ischemic cause	Congenital malformation	Total
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Pre-term	0	5 (45.5)	4 (36.4)	2 (18.2)	0	11 (100)
Term and post-term	6 (16.2)	4 (10.8)	23 (62.2)	0	4 (10.8)	37 (100)
Total	6	9	27	2	4	48

n: Number of patients, PVL: Periventricular leukomalacia

Table 3: MRI patterns according to cerebral palsy subtypes

MRI pattern types	Spastic diplegia	Spastic quadriplegia	Hemiplegia	Non-spastic	Total
	n (%)	n (%)	n (%)	n (%)	n (%)
Normal	3 (13.0)	-	1 (20.0)	2 (66.7)	6 (12.5)
PVL	7 (30.4)	2 (11.8)	-	-	9 (18.8)
Diffuse encephalopathy	12 (52.2)	11 (64.7)	3 (60.0)	1 (33.3)	27 (56.2)
Ischemic cause	-	1 (5.9)	1 (20.0)	-	2 (4.2)
Congenital malformation	1 (4.4)	3 (17.6)	-	-	4 (8.3)
Total	23 (100)	17 (100)	5 (100)	3 (100)	48 (100)

n: Number of patients, PVL: Periventricular leukomalacia

Discussion

In the present study, there was male predominance (70.8%). A slightly lower percentage (68%) was reported in a study carried out in Australia [6]. Some authors reported that male gender is a risk factor for CP [7]. Factors playing role in the etiology of CP interact with each other. A relatively large percentage of the cases in this study had no prenatal risk factors (62.5%). The rest 37.5% had one or more risk factors. The commonest risk factor was prematurity followed by maternal diseases, perinatal asphyxia, twin gestation and neonatal hyperbilirubinemia. It is presumed that certain radiological findings are suggestive for birth asphyxia, such as PVL, cystic encephalomalacia, localized atrophy, and gliosis with or without basal ganglia involvement [8].

The most common clinical type of CP was spastic diplegia, seen in 48% of cases. This figure is close that in a study performed at the Neurosciences Hospital of Baghdad, in which spastic diplegia constituted about 43% of all CP cases [9]. These results were also similar to studies conducted in the developed countries [2,10]. Spastic quadriplegia (35%) was the next most common type in the current study. In a study carried out in Indian, Spastic quadriplegic involvement was the most common type of CP [8]. In two separate studies conducted at Al-Kindy and AL-Mansour teaching hospitals in Baghdad, the quadriplegic CP was the most common type [5,11]. One can conclude that, the clinical spectrum of CP is different in developing countries compared to developed countries, but the result of our study was closer to that of developing countries. Hemiplegic CP is not common in our study, and accounted for 10.4%, which was higher than that reported by other authors [12]. Convulsion abnormalities were reported in 18% of our patients; higher percentages were reported by others [10].

In different European studies, the MRI abnormalities ranged from 86% to 89% [4,10,13]. This was in agreement with our current results (87.5%). Unlike these results, Benini and Shevell [14] found that 29% of the examined patients had normal MRI findings, which was dominated by dyskinetic CP. The results of the current study showed a higher proportion of diffuse encephalopathy and periventricular white matter disease, and a lower proportion of malformations and ischemic lesions.

Data from previous researches showed that the less severely affected children were more likely to have a normal MRI. Spastic monoplegia and diplegia were the commonest types of CP in the Robinson study [2]. PVL is the commonest MRI abnormality in developed countries. In 3 different studies, PVL constituted 56% (4), 42.5% (10), and 31.2% [2] of all MRI abnormalities, respectively. In the current study, diffuse encephalopathy was the commonest MRI abnormality, constituting 56.2% of all MRI abnormalities. Most of them (88%) showed cortical and sub cortical atrophy, and (11%) of them showed multi-cystic encephalomalacia. The multi-cystic encephalomalacia is more often found in term than preterm newborns and the prognosis is unfavorable [15].

Congenital brain malformations develop during the 1st and 2nd trimesters [16]. In this study, brain malformations were observed in 4 children (8.3%), all were full-term babies, and 75% showed quadriplegic type of CP. Ischemic/hemorrhagic lesions, seen only in 2 cases (4.2%), both occurred in pre-term

babies. They are seen on MRI as post-hemorrhagic or post-infarction porencephaly. This is thought to be the result of perinatal stroke. Previous studies showed more cases of focal ischemic lesions: the rates were 16.2% in Robinson et al [2] and 7.4% in Bax et al. [10].

Limitations

Children were imaged over a wide age range, which can affect the interpretation of MR images. The machine used for MR imaging had field strength of 1.5 Tesla only, and the head coil used was designed for adults. Complications during the administration of general anesthesia ended with discontinuation of the MRI scan. Many cases were postponed due to chest infections, which are common among children. National obstetrics and the neonatal medical record systems were insufficient, which is a pressing problem in most of the developing countries.

Conclusions

This study concluded that diffuse encephalopathy is a common MRI abnormality in children with CP. MRI in children with CP is relatively of value in understanding the pathogenesis of CP and it is diagnostic in congenital brain malformations. Neuro-radiological classification of CP can be applied to all patients and CP is more common among the male gender.

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