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Subfalcine Herniation:Correlation Of Midline Shift With Neurological Status

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Abstract

Background:
Sub-falcine herniation is the most common type of intracranial herniation, occurring when unilateral brain pathology causes a medial mass effect, pushing the cingulate gyrus beneath the falx cerebri. The degree of midline shift on imaging correlates with prognosis: shifts of less than 5 mm are linked to better outcomes, while shifts greater than 15 mm predict poorer outcomes. CT and MRI are essential for diagnosis.

Objectives:
Identify sub-falcine herniation using CT and MRI.
Correlate midline shift with neurological status, as indicated by the Glasgow Coma Scale (GCS).

Materials&Methods:
A prospective study at Rajindra Hospital, Government Medical College, Patiala, included 40 patients suspected of sub-falcine herniation. CT and MRI scans, with contrast as needed, were performed using a GE Medical Systems Revolution EVO 128-slice MDCT and a Siemens 1.5T Magnetom Aera MRI scanner. Midline shift was measured, and its correlation with GCS scores was analyzed using SPSS software**.**

Results:
The mean age was 48.22±19.03 years, with a male predominance (77.5%). Subdural hematoma was the most common cause (42.5%). GCS scores were 13-15 in 50% of patients, 3-8 in 27.5%, and 9-12 in 22.5%. CT results showed midline shifts of <5 mm in 27.5%, 5-10 mm in 45%, and 10-20 mm in 27.5%. A negative correlation was found between GCS and midline shift: greater shifts were associated with lower GCS scores.

Conclusion:
Sub-falcine herniation predominantly affects males and is often due to subdural hematoma. Increased midline shift correlates with worse neurological status, as reflected by decreased GCS scores.

Keywords: Subfalcine herniation, Midline shift, GCS, cingulate gyrus

Introduction

Subfalcine herniation, also called as a cingulate hernia or midline shift, represents the most prevalent form of intracranial herniation. It occurs when brain tissue is displaced beneath the falx cerebri.[1] It typically arises

from unilateral frontal, parietal, or temporal lobe pathology that creates a mass effect, causing displacement of the cingulate gyrus, and as it progresses it can also involve the frontal lobe. It can also result in focal necrosis of the cingulate gyrus due to direct compression against the falx cerebri.[2,3] . The same side corpus callosum is lower and higher with compression of the opposite side corpus callosum. Mild subfalcine herniation causes compression of the ipsilateral lateral ventricle and dilation of the contralateral lateral ventricle.[4]The displacement of the septum pellucidum at the foramen of Monro is an important marker for assessing midline shift (MLS). The modification can be determined on axial scans by positioning a central line at the level of the foramen of Monro and measuring the distance to the displacement of the septum pellucidum. In severe hernia cases, the pushed tissue can press on the corpus callosum, cingulate gyrus, ventricle, and foramina of Monro, causing enlargement of the opposite ventricle. This may result in focal necrosis of the cingulate gyrus. The prognosis of cerebral herniation relies on several factors, including the underlying cause of herniation, the degree of intracranial pressure elevation, the presence and duration of cerebral ischemia resulting from herniation, and which specific cerebral structures are affected due to complications.(4)A midline shift (MLS) of <5 mm typically indicates a favorable prognosis, whereas a shift exceeding 15 mm is associated with a poorer outcome.(5) Hence, the present study aims to identify the correlation of midline shift on CT and MRI with patient with neurological status.

Materials & Methods

The patients referred to department of Radiodiagnosis, Rajindra Hospital, Patiala with clinically suspected brain herniation syndrome, mainly subfalcine herniation were subjected to CT and MR imaging with appropriate sequences with contrast administration as required. Clinical history regarding the onset of symptoms and clinical progression of the disease process were taken. Midline shift was evaluated and its correlation with patient outcome. The spectrum of findings was recorded as per the proforma.

Inclusion criteria: Patients showing sub-falcine herniation on CT or MR imaging.

Exclusion criteria:

1. Patients not giving consent.
2. Patients having history of claustrophobia.
3. Patients having ferromagnetic implants, cardiac pacemakers, cochlear implants and metallic foreign body in situ will be excluded from MRI

Imaging was performed using CT machine (GE Medical Systems Revolution EVO 128 slice MDCT machine for image acquisition)/ MRI scanner (Siemens 1.5T Magnetom aera MRI machine). All the results were summarized in Microsoft excel sheet and were analyzed by SPSS software.

Results

All the results were subjected to statistical analysis. It was observed that that the mean age was 48.22±19.03 years. Maximum number of patients was in the age group of ≤40 years. The age range of the patients was 11-85 years.(Table 1).There was a male preponderance among the patients with 77.5% males and 22.50% females.(Figure 1).

Table 1: Age Distribution Of Patients

Age Group (Years)	Patients	Percentage
≤30 years	8	20%
31-40 years	8	20%
41-50 years	6	15%
51-60 years	6	15%
61-70 years	7	17.50%
>70 years	7	17.50%

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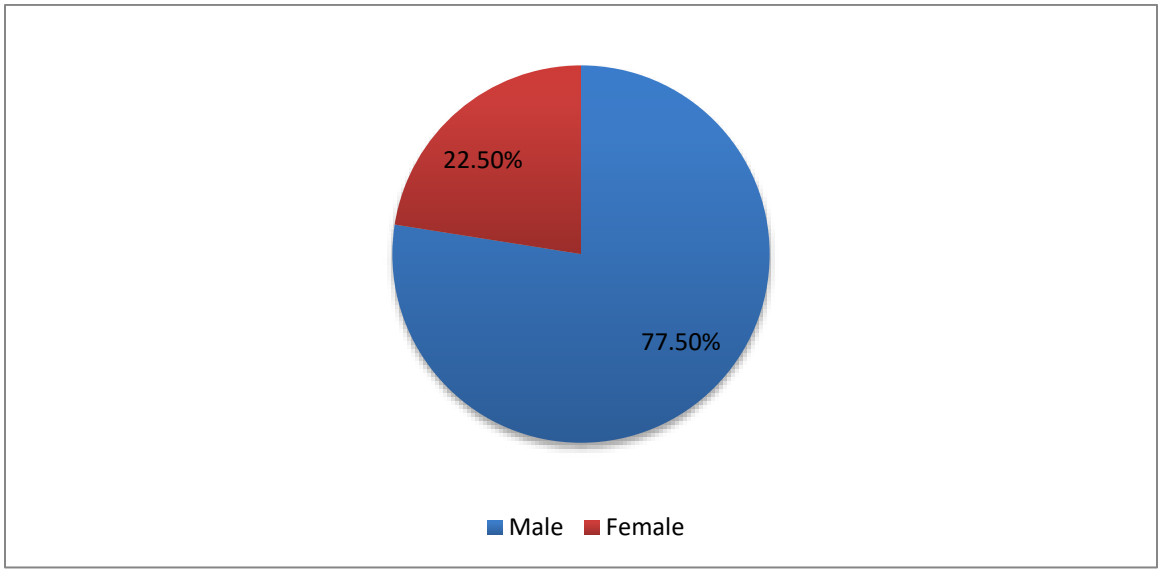
Total	40	100%
Mean±SD	48.22±19.03	
Range	11-85	

Figure 1: Gender Distribution



The most common pathological finding that led to sub-falcine herniation was Subdural hematoma seen in 42.5% patients followed by hemorrhagic contusions, subarachnoid hemorrhage and intraventricular hemorrhage in 25% followed by extradural hematoma (20%) pneumocephalus (7.5%) , space occupying lesion ,subacute infarct , acute infarct in 5% & haemorrhagic metastasis , glioblastoma multiforme, age related cerebral atrophy ,diffuse cerebral edema and dermoid cyst in 2.5% patients.(Table 2)

Table 2: Diagnosis

Diagnosis	Patients	Percentage
Subdural hematoma	17	42.5%
Haemorrhagic contusions	10	25%
Subarachnoid hematoma	10	25%
Intraventricular haemorrhage	10	25%
Extradural hematoma	8	20%
Pneumocephalus	3	7.5%
Space occupying lesion	2	5%
Subacute infarct	2	5%
Acute infarct	2	5%
Haemorrhagic metastasis	1	2.5%
Glioblastoma multiforme	1	2.5%

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Age related cerebral atrophy	1	2.5%
Diffuse cerebral edema	1	2.5%
Dermoid cyst	1	2.5%

On Initial assessment the GCS was as follows: 50% patients were found to have GCS 13-15, 27.50% patients had GCS 3-8 and 22.50% patients had GCS 9-12. The mean GCS of study participants was 11.15±3.49. 45% patients were having MLS >5-10 mm, and 27.50% patients each with MLS of <5mm and >10-20mm . The mean MLS was 8.60±5.02(range-3-20mm) . In 10 patients with GCS (3-8), 3 patients (7.50%) had MLS (>5-10 mm), and 7 patients (17.5%) had MLS (>10-20 mm). The mean MLS was 13.48±5.62 mm. In 10 patients with GCS (9-12), 8 patients (20%) had MLS (>5-10 mm), and 2 patients (5%) had MLS (>10-20 mm). The mean MLS was 9.08±1.95 mm. Whereas in 20 patients with GCS (13-15), 11 patients (27.5%) had MLS (≤5 mm), 7 patients (17.50%) had MLS (>5-10 mm), and 2 patients (5%) had MLS (>10-20 mm). The mean MLS was 5.92±3.84 mm.

The Pearson Correlation Coefficient was -0.7038 which showed negative correlation (i.e., value of GCS decreases with increase in the MLS). The correlation was statistically highly significant (p value < 0.00001).(Table 3)

Table 3: Relationship Of Midline Shift With Patient's Neurological Status

	GCS (3-8)	**GCS (9-12)**	**GCS (13-15)**
MLS (≤5 mm)	0 (0%)	0 (0%)	11 (27.5%)
MLS (>5-10 mm)	3 (7.50%)	8 (20%)	7 (17.5%)
MLS (>10-20 mm)	7 (17.5%)	2 (5%)	2 (5%)
Mean(±SD) MLS	13.48±5.62	9.08±1.95	5.92±3.84
Pearson Correlation Coefficient	-0.7038 (moderate negative correlation)		
P Value	< 0.00001 (HS)		

Discussion

In our study the mean age was 48.22±19.03 years. Maximum number of patients was in the age group of ≤40 years. The age range of the patients was 11-85 years.

Khorasanizadeh M et al reported that age of patients ranged from 25 to 94 years (mean 71.6 years).[6] Won YD et al reported that the mean age of patients with acute traumatic SDH was 65.4 years.[7] Suraj HS et al (2022) found that the majority of the patients were males (55.74%).[8] Similarly, Won YD et al found that majority of the patients were male. [9]

The most common pathological finding that led to sub-falcine herniation was Subdural hematoma seen in 42.5% patients followed by hemorrhagic contusions, subarachnoid hemorrhage and intraventricular hemorrhage in 25% followed by extradural hematoma (20%) , pneumocephalus (7.5%) , space occupying lesion ,subacute infarct , acute infarct in 5% & haemorrhagic metastasis ,glioblastoma multiforme, age related cerebral atrophy ,diffuse cerebral edema and dermoid cyst in 2.5% patients.

Chaurasia et al (2021) reported that the most common CT finding was hemorrhagic contusion accounting for 56% of the cases.[10] Ratnakar (2014) reported that Cerebral contusion (28.7%) was the most common CT scan finding in the patients of craniocerebral injury followed by depressed fracture (25.1%), subdural hematoma (15.3%) than extradural hematoma (9.7%).[11]

The majority of patients (50%) had Glasgow Coma Score (GCS) of 13-15, followed by 10 patients (25%) each with GCS of 3-8 and 9-12. The mean GCS was 11.27±3.31 (range 6-15). Regarding GCS-P, the majority of patients (50%) had GCS-P of 13-15,

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followed by 11 patients (27.50%) with GCS-P score of 3-8 and 9 patients (22.50%) with GCS-P score of 9-12. The mean GCS-P score was 11.15±3.49 (range 5-15). Blaauw J et al (2022) reported that the mean GCS was 14.2±1.5 in patients with chronic subdural hematoma.[12] Gautam S et al (2018) reported that in 100 patients of acute subdural hematoma, at time of presentation, 36 patients were present in each group with GCS < 8 and 9-13 groups. Remaining 28 patients had GCS 14-15.[13]

Midline shift

The majority of patients (45%) had MLS of >5-10 mm, followed by 11 patients (27.50%) each with MLS of ≤5 mm and >10-20 mm. The mean MLS was 8.60±5.02 mm (range 3-20 mm).

Blaauw J et al (2022) reported that the mean MLS was 6.90±5.3 mm.[12] Gautam S et al (2018) reported that in 100 patients of acute subdural hematoma, 11.76% patients with MLS <5mm, and 45.45% patients with MLS >5 mm.[11]An MLS is related to the subsequent change in brain position due to the hematoma taking up space. Brain shift also serves as a predictor of negative neurological impacts.[14]

Relationship of midline shift with patient's neurological status

In the present study, in 10 patients with GCS (3-8), 3 patients (7.50%) had MLS (>5-10 mm), and 7 patients (17.5%) had MLS (>10-20 mm). The mean MLS was 13.48±5.62 mm. In 10 patients with GCS (9-12), 8 patients (20%) had MLS (>5-10 mm), and 2 patients (5%) had MLS (>10-20 mm). The mean MLS was 9.08±1.95 mm. Whereas in 20 patients with GCS (13-15), 11 patients (27.5%) had MLS (≤5 mm), 7 patients (17.50%) had MLS (>5-10 mm), and 2 patients (5%) had MLS (>10-20 mm). The mean MLS was 5.92±3.84 mm. The Pearson Correlation Coefficient was -0.7038 which showed negative correlation (i.e., value of GCS decreases with increase in the MLS). The correlation was statistically highly significant (p value < 0.00001).It is important to note a few of the current study's shortcomings. The study's short timeframe and small sample size restrict the applicability of its findings to wider geographic areas. Larger-scale prospective randomised trials in the future will enable more reliable research and significantly improve the findings of the present study.

Conclusion

The present study revealed that with subfalcine herniation in more common in males. Subdural hematoma, Haemorrhagic contusions, Subarachnoid hematoma, and Intraventricular haemorrhage are the most common causes for subfalcine herniation. The study concluded that with increase in the level of midline shift, the neurological status (as reflected by Glasgow coma scale score) deteriorates.

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There was no source of funding for our research.

Ethical approval and Consent

Approval was taken from the relevant ethics committee and written informed consent was taken from each patient to publish his details while maintaining confidentiality.

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