Analysis of Complications of Subfalcine Herniation on CT and MRI and Estimation of their Incidence

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Abstract:-

➢ ***Background***

Subfalcine herniation is the most common type of intracranial herniation. It occurs when brain tissue is pushed under the falx cerebri. Focal necrosis of the cingulate gyrus can occur from direct compression against the falx cerebri. An MLS less than 5 mm suggests a positive outcome, while a shift greater than 15 mm indicates a worse outcome. Prognosis for cerebral herniation depends on factors like the cause, intracranial pressure, cerebral ischemia, and affected brain structures.

➢ ***Objectives***

To identify and estimate the incidence of complications from subfalcine herniation on CT and MRI.

Materials & Methods

The study was conducted prospectively in the Department of Radiodiagnosis, Rajindra hospital, Government Medical College, Patiala on 36 patients who were referred with clinical symptoms and signs of brain herniation due to any etiology. All the patients were subjected to MRI and CT scan. 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***

The mean age of 51±19.26 years with a male preponderance (58.33% males). Hypertensive bleed and intra-axial lesion (25% patients each) were the most common pathological finding that led to subfalcine herniation. On initial assessment, 63.89% patients had GCS 9-12, 19.44% had GCS 13-15 and 16.67% had GCS 3-8. On CT scan, our study found that 22.22% patients were having MLS ≤5 mm, 30.55% patients between 6 to 10 mm, 41.67% patients between 11 to 20 mm and 5.55% patients had shift >20 mm. Subfalcine herniation led to complications like hydrocephalus (58.33%), ACA infarct (25%), Hydrocephalus with 3rd cranial nerve palsy (8.33%), Hydrocephalus with Duret hemorrhage (5.56%) and PCA infarct (2.78%).

➢ ***Conclusion***

A weak correlation between suspected raised ICP and patient outcomes was noted. Prompt diagnosis relies on CT and MRI scans. Initial symptoms may be subtle, emphasizing the need for comprehensive evaluation and rapid imaging. Early intervention is pivotal for improving outcomes and managing complications associated with cerebral herniation.

Keywords:- *Subfalcine Herniation, Midline Shift, Hydrocephalus, ACA Infarct, PCA Infarct.*

I. 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] In subfalcine herniation, the amount of midline shift correlates closely with the prognosis. A midline shift (MLS) of <5 mm typically indicates a favorable prognosis, whereas a shift exceeding 15 mm is associated with a poorer outcome.[4] 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.[5,6] Hence, the present study aims to identify

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the various complications of subfalcine herniation on CT and MRI and estimate their incidence.

II. MATERIALS & METHODS

The present study was a prospective study was conducted in the Department of Radiodiagnosis, Rajindra hospital, Government Medical College, Patiala. A total of 36 cases who were referred with clinical symptoms and signs of brain herniation due to any etiology were enrolled. Informed written consent was taken from all the patients/ attendants. The enrollment was based on the following inclusion and exclusion criteria-

- *Inclusion Criteria:*
  - Patients referred to radiology department for brain CT or MRI who show signs of brain herniation due to any etiology.
  - Patients and their relatives willing to give informed written consent to take part in the study.

- *Exclusion Criteria:*
  - Patients who are unstable and unable to lie down for a CT or MRI scan.
  - Post operative patients especially brain surgeries
  - Inability to provide consent
  - Pregnant females

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.

III. RESULTS

All the results were subjected to statistical analysis. It was observed that the mean age of the patients was 51.00±19.26 years (range 19-95 years). There was a male preponderance among the patients with 58.33% males and 41.67% females.

The most common pathological finding that led to subfalcine herniation was hypertensive bleed and intra-axial lesion was seen in 25% patients each followed by ring enhancing lesion and traumatic bleed seen in 16.67% patients each followed by extra axial lesion and stroke in 8.33% patients each. Out of 36 patients, 19 patients had clinical features suggestive of raised ICP. On Initial assessment the GCS was as follows: 63.89% patients were found to have GCS 9-12, 19.44% patients had GCS 13-15 and 16.67% patients had GCS 3-8. The mean GCS of study participants was 10.80±2.55. 22.22% patients were having MLS ≤5 mm, 30.55% patients between 6 to 10 mm, 41.67% patients between 11 to 20 mm and 5.55% patients had shift >20 mm. The mean MLS was 10.29 ± 4.86.

The most common complication due to subfalcine herniation was hydrocephalus (58.33%), followed by ACA infarct (25%), Hydrocephalus with 3rd cranial nerve palsy (8.33%), Hydrocephalus with Duret hemorrhage (5.56%) and PCA infarct (2.78%). Hydrocephalus was observed in 8/9 patients (22.22%) with hypertensive bleed, 5/9 patients (13.89%) with intra-axial lesions, 3/6 patients (8.33%) with traumatic bleed, 3/3 patients (8.33%) with extra-axial lesions, and 2/6 patients (5.55%) with ring-enhancing lesions. ACA infarct was observed in 3/9 patients (8.33%) with intra-axial lesions, 3/6 patients (8.33%) with ring-enhancing lesions, 2/3 patients (5.55%) with stroke, and 1/9 patients (2.78%) with hypertensive bleed. Hydrocephalus with Third cranial nerve palsy was observed in 1/9 patients (2.78%) with intra-axial lesions, 1/6 patients (2.78%) with ring-enhancing lesions, and 1/6 patients (2.78%) with traumatic bleed. Hydrocephalus with Duret hemorrhage was seen 2/6 (5.55%) patients of traumatic bleed. PCA infarct was seen in 1/3 patient (2.78%) of stroke.

IV. DISCUSSION

In our study, it was observed that the mean age of the patients was 51.00±19.26 years (range 19-95 years). There was a male preponderance among the patients with 58.33% males and 41.67% females. Kalita et al and Wettervik et al also reported the mean age of patients to be 51 (± 9.26) and 54 years, respectively.[7,8] Similarly, Kalita et al, Puffer et al and Wettervik et al found that majority of the patients were male.[7,8,9]

Hypertensive bleed and intra-axial lesion (25% patients each) were the most common pathological finding that led to subfalcine herniation, followed by ring enhancing lesion and traumatic bleed (16.67% patients each), extra axial lesion and stroke (8.33% patients each). Lau et al reported that one-third stroke patients had diabetes.[11] While, Setyopranoto et al found 73.91% of stroke patients had hypertension.[12]

On initial assessment, 63.89% patients had GCS 9-12, 19.44% patients had GCS 13-15 and 16.67% patients had GCS 3-8. Bayleyegn NS et al reported that out of 91 patients, 49.4% patients had GCS 14-15, 37.4% patients had GCS 10-13, and 13.2 % patients had GCS 3-9.[12] Choudhary A et al (2021) reported that out of 56 patients with head injury, there were 51.35% patients had GCS score 3–8, 30.36% patients had GCS score 9–12, and 14.28% had GCS score 13–15.[13] Sobti S et al reported that out of 38 patients with head injury, 33 had a score of 14 or 15, whereas four had a score between 9 and 13 and one had a score below 9.[14] On CT scan, our study found that 22.22% patients were having MLS ≤5 mm, 30.55% patients between 6 to 10 mm, 41.67% patients between 11 to 20 mm and 5.55% patients had shift >20 mm. Puffer et al reported 1 to 5 mm MLS in 66% patients, 24.5% patients had MLS between 6 to 10 mm and 9.50% patients more than 10 mm.[15] Similarly, Kalita et al found that MLS 3-6 mm in 27.27%, 6-9 mm in 36.36% and MLS >9 mm in 36.36% patients.[16]

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In our study, subfalcine herniation led to complications like hydrocephalus (58.33%), ACA infarct (25%), Hydrocephalus with 3rd cranial nerve palsy (8.33%), Hydrocephalus with Duret hemorrhage (5.56%) and PCA infarct (2.78%). It was observed that gross mechanical shift of the brain and herniation across the falx and/or tentorium accounted for 20.75% cases of ACA infarction in a study by Mirvis et al[17] and 18.75% patients in study by Server et al.[18] This highlights the significant impact of brain herniation on vascular compromise and subsequent infarction, particularly involving the ACA. Chen et al reported an incidence of hydrocephalus 69.54% in trauma cases and 16.10% in nontraumatic causes.[19] Owen et al found 46.1% patients developed hydrocephalus from intraventricular hemorrhage. Rufus et al also found 31.6% developed post-traumatic hydrocephalus.[20]

The imaging findings can vary from subtle alterations to clear displacement of brain structures. It is essential to identify the primary imaging features associated with different subtypes of brain herniation.[1,21] Compression of structures such as the posterior cerebral artery, third cranial nerve, and aqueduct of Sylvius can lead to infarcts in the medial temporal and occipital lobes, blown pupil, hemiparesis, and hydrocephalus.[1,21]

There are few limitations of the present study. This study was conducted at a single institute and focused on a specific group within the Indian population. The group of patients chosen may not accurately reflect the geographical and demographic makeup of the overall Indian population.

V. CONCLUSION

The current study observed a weak correlation between suspected elevated ICP and patient outcome. Quick diagnosis depends on CT and MRI scans, with CT being especially important in urgent situations to detect conditions requiring immediate surgery. MRI provides exceptional tissue clarity, particularly for conditions affecting the posterior fossa. Patients frequently need close monitoring and consultation with neurosurgeons to prevent worsening. Early signs can be mild, underlining the importance of thorough assessment and quick imaging. Treating the root cause is done through procedures like surgically removing mass lesions and possibly performing decompressive craniectomy. Timely intervention is crucial for enhancing results and addressing potential issues linked to cerebral herniation.

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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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