

A STUDY OF NORMAL MRI MEASUREMENTS OF OPTIC CHIASMA AND ITS CORRELATION WITH PERICHIASMALESIONS

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ABSTRACT

BACKGROUND

Cranial MRI is routinely performed in which optic chiasma is visualised as part of optic pathways. Chiasma can be affected by various pathologies. Its deviation from normal dimensions can easily be calculated on routine cranial MRI.

METHOD

This study was done retrospectively evaluating twenty consecutive cranial MRI examinations. T2WI images were included in this study as it was a part of routine protocol and were used for evaluation. One case from another setup was included in this study to highlight the importance of measurements.

RESULTS

The normal and abnormal measurements were calculated with submillimetre digital caliper and are described in Table 1-2. The parameters used were width, height and area of optic chiasma.

CONCLUSION

This study highlights the usefulness of evaluating optic chiasma to diagnose various visual and nonvisual-related conditions. Objective measurements of optic chiasma should be done routinely in T2WI coronal images.

KEYWORDS

Optic Chiasma, Chiasmal Measurements, Submillimetre Caliper Measurements.

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INTRODUCTION: Optic chiasma is an important structure routinely seen in cranial MRI studies. MRI has an excellent spatial resolution of chiasma. Normal measurements can be regularly made with the help of digital submillimetre calliper. Optic chiasma is commonly a dumbbell-shaped structure in suprasellar cistern. Anteriorly, this structure continues as optic nerves and posteriorly as optic tracts. MRI cranium is routinely done in both nonvisual and visual-related disorders. Optic chiasma is routinely identified structure on coronal T2WI images. It is seen as a well-defined T2 homogeneously hypointense structure. Chiasma consist to fibres from both optic nerves and is surrounded by many structures. Therefore, chiasma is vital point where small pathology from intra-axial or extra-axial lesions can significantly impair visual acuity as compared to any other point in optic pathway. Measurements of this structure is important to exclude subtle radiological changes occurring due to primary and secondary chiasmal lesions. Identification of chiasmal lesions is helpful to guide neuro-

ophthalmologist in further management. Also, identification of early chiasmal abnormality explains the visual and other clinical manifestations. The various parameters used for measuring optic chiasma were maximal height (both right and left sides of optic chiasma), width and area. A retrospective study was done from 2015 to 2016 on twenty patients. We describe the normal measurements and correlate it with various abnormalities related to chiasma. A rare case of nonvisualisation of optic chiasma diagnosed at another hospital is also documented in this study.

AIM AND OBJECTIVES:

- 1) To measure the normal dimensions of optic chiasma and calculate the normal range.
- 2) To correlate the normal range with various chiasmal lesions.

MATERIAL AND METHOD: This study was done retrospectively evaluating twenty consecutive cranial MRI examinations. These cranial examinations were referred for both nonvisual and visual-related disorders. MRI examination were performed on 0.3 tesla, Siemens Somatom MR System using routine imaging protocols. T2WI images were also acquired in this study as it was a part of routine protocol and were used for evaluation. T2WI images were acquired in coronal plain with 4 mm section thickness.

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The number of male and female patients were eight and twelve, respectively. The age ranged from thirty one to seventy years.

In this study, fourteen were normal cases, which were evaluated for normal measurements. Six had abnormal associated findings in which optic chiasma showed subtle abnormal measurements. One child had a cranial MRI done at another hospital and its study is added to the current series. This is a two-year-old child with history of blindness and deafness was included. The study was done on 1.5 tesla MRI.

The MRI cases were transferred to PACS workstation. Studies which had clear demonstration of chiasma on T2WI were included. The best image in the study optimally demonstrating optic chiasma in T2WI coronal plain with no surrounding vascular indentation was selected for calculation of normal measurements. There was usually only one section in which optic chiasma was seen. In cases, where two sections of optic chiasma were seen, the best section was selected. Suboptimal studies as well as images with artifacts or movement blur were excluded from this

study. Rarely, optic chiasma is not identified on MRI studies due to congenital abnormality.

The images were evaluated for various parameters, which included height, width and area of optic chiasma (image 1). The maximal height of right and left half of optic chiasma were measured. Care was taken to exclude the closely abutting vascular flow voids that were easily identified on T2WI.

RESULTS: The normal measurements were calculated with submillimetre caliper in PACS, which included width, area and height of optic chiasma (Table 1).

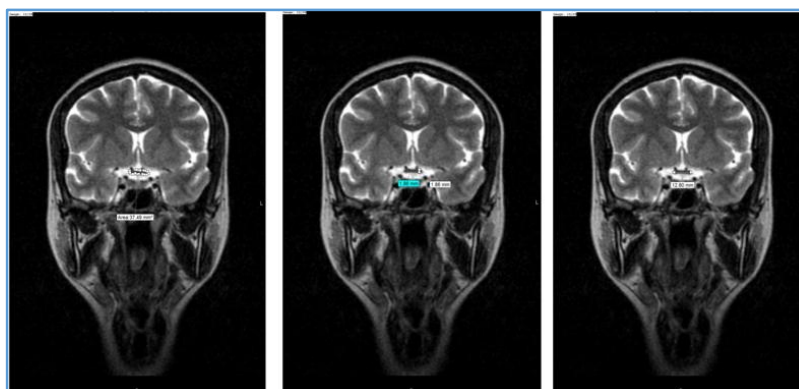
The measurements in various abnormalities are given in Table 1 and Table 2, which includes diffuse cerebral atrophy, macroadenoma, arachnoid cyst in suprasellar region, chiasmal infiltration from extra-axial mass and third ventricular enlargement due to hydrocephalous. An abnormal measurement was also included resulting from oblique coronal imaging after careful evaluation of T2WI images. Nonvisualisation of optic chiasma was routinely considered as inappropriate imaging, however, a rare case of aplasia of optic chiasma is documented in this study.

Sl. No.	Measurements	Mean Normal	Median Normal	SD Normal	+2SD Normal	-2SD Normal	Diffuse Cerebral Atrophy	Arachnoid Cyst	Pituitary Macroadenoma
1.	Area (mm ²)	30.70	31.27	6.12	42.94	18.46	21.36	21.70	22.94
2.	Width (mm)	12.14	11.79	1.54	15.22	9.06	11.9	13.6	9.28
3.	Height Right side (mm)	1.87	1.95	0.51	2.89	0.85	1.3	1.67	0.74
4.	Height Left side (mm)	1.88	1.95	0.52	2.92	0.84	1.67	1.48	1.30

Table 1

Sl. No.	Measurements	Chiasmal Infiltration (Pseudochiasmal Enlargement)	Oblique Coronal T2WI	Third Ventricular Enlargement Due to Hydrocephalous
1.	Area (mm ²)	237	30.29	30.20
2.	Width (mm)	18	10.71	13.69
3.	Height Right side (mm)	13	2.04	2.27
4.	Height Left side (mm)	14	1.68	1.40

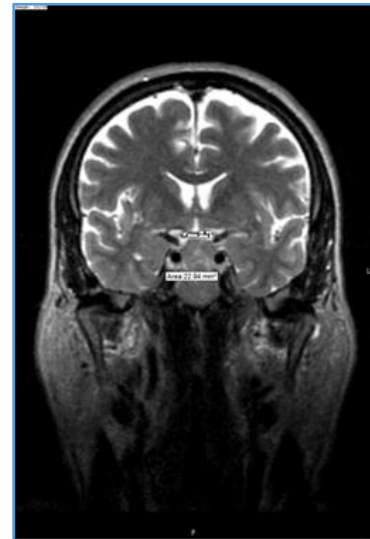
Table 2



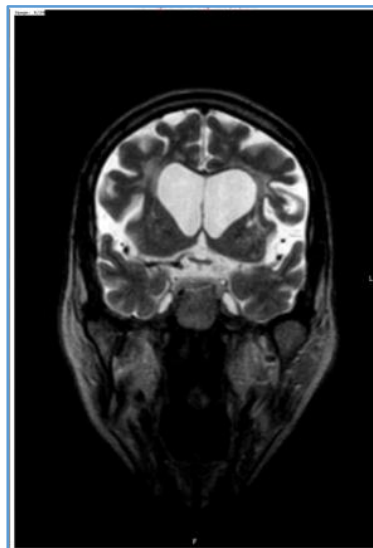
Normal Measurements of Optic Chiasma with Submillimetre Caliper



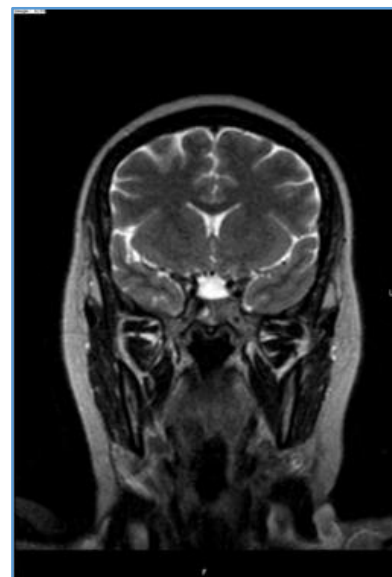
Optic Chiasmal Pseudoenlargement from Extra-Axial Infiltrative Lesion



Macroadenoma



Diffuse Cerebral Atrophy



Arachnoid Cyst



Hydrocephalous Causing Club-Shaped Deformity of Chiasma

DISCUSSION: Optic chiasma forms an important part of visual pathway. It lies in chiasmatic cistern above the pituitary fossa.⁽¹⁾ Optic chiasma lies typically about 10 mm above the pituitary gland. Its location are: directly over sella (80%), prefixed (10%) and postfixed (10%).⁽²⁾

It is separated from optic recess of third ventricle superiorly and inferiorly from pituitary gland. A1 segment of ACA, ICA and MCA are in close relation to lateral aspect of chiasma. Infundibulum is posteroinferiorly related to optic chiasma.⁽³⁾

It receives the optic nerves by its anterior angles and emits the optic tracts by its posterior angles.^(4,5) Chiasma consists of crossed and uncrossed optic nerve fibres with few fibres that connect to both medial geniculate bodies. Chiasma is supplied by vascular branches from all the vessels in the vicinity including the ophthalmic, anterior cerebral, anterior communicating and carotid artery, the hypophyseal arteries, middle cerebral and posterior communicating arteries and the anterior choroidal artery.⁽⁶⁾ It is usually seen as dumbbell-shaped structure.⁽⁵⁾ However, few variations

were seen in the form of rectangular or curvilinear shape. Various primary and secondary disease can cause alteration in optic chiasma measurements ranging from neoplasms of chiasma-perichiasmal regions, infections, cerebrovascular diseases, demyelinating disease to rarely congenital abnormality.

MRI is an excellent imaging modality with multiplanar capability for evaluation of soft tissue structures like optic chiasma and its adjacent structures. Cranial MRI examination routinely demonstrates this structure on T2WI coronal sections. It's difficult to assess optic chiasma in sagittal sections. Often additional dedicated studies like thin T1WI studies have to be performed. The disadvantages of these studies are that they are time consuming and expensive. Therefore, one needs to assess optic chiasma for any lesion in routine studies.

The width measurements of chiasma correlated with study done by Andrew L. Wagner et al.⁽⁵⁾ However, few variation in measurement of area of chiasma were seen. However, our measurements does not correlate with study done by Parravano JG et al⁽⁷⁾ possibly due to handheld digital calipers and inherent errors in their studies.

In our study, none of the optic chiasma showed increased T2WI signal intensity. However, in a study by Albert A,⁽⁸⁾ there were altered T2 signal intensity in seven out of eight verified optic chiasmal lesions, which could be attributed to tumorous and secondary haemorrhagic lesions included in study that are more likely to cause signal alteration. In comparison, our study included all types of lesions ranging from non-tumorous to non-haemorrhagic lesions. This signifies that the altered signal intensity is a delayed manifestation. Hence, any changes in optic chiasmal dimensions should be considered significant and needs to be correlated clinically. Asymmetry in optic chiasmal height were either due to atrophy or mass effect. The most likely cause of reduction of width was compression of optic chiasma by macroadenoma (Image 2).

This is due to mass effect rather than infiltration, later would usually cause enlargement of optic chiasma. Pituitary macroadenoma, aneurysm, craniopharyngioma, etc. are commonly lesions that causes mass effect on chiasma.

The enlargement of optic chiasma is usually noted in primary chiasmal tumours like gliomas whereas secondary chiasmal tumours included infiltrative lesions like leukaemia, lymphoma, etc. and metastasis as well as in infantile Krabbe's syndrome. The area of optic chiasma was 53% greater than normal in a case of infantile Krabbe's syndrome.⁽⁹⁾ In this study, an extra-axial infiltrative lesion (Image 3) caused pseudoenlargement of chiasmal region (Table 2) with effacement of chiasmatic cistern.

The optic chiasma can be deformed by third ventricular enlargement⁽¹⁰⁾ due to hydrocephalous in both types: communicating and non-communicating. Ballong of third ventricle causes dilatations of its recesses: optic, infundibular, pineal. The dilatation of optic recess causes mass effect on chiasma. In our case, there is asymmetrical enlargement of third ventricle causing flattening and

depression of left half of optic chiasma (Table 2) giving rise to club-shaped deformity (Image 4).

Suprasellar arachnoid cyst can also cause deformity of optic chiasma when they are large.⁽¹¹⁾ Arachnoid cyst are difficult to identify lesions when they are small as noted in our case. There are two types of arachnoid cysts: communicating and non-communicating. It's the noncommunicating type of arachnoid cyst that enlarges in size. However, in our case, the arachnoid cyst did not cause significant mass effect on chiasma; most likely, it was a communicating type of arachnoid cyst.

Chiasmal atrophy can occur due to ischaemic and compressive causes.^(12,13) There are numerous vessels around chiasma, which can be affected resulting in impairment of chiasmal vascular supply. These commonly includes atherosclerotic diseases, vasculitis, etc. Compressive causes includes space occupying lesions like tumours, aneurysm, haematoma, etc. In the case of diffuse cerebral atrophy (Image 6), there was asymmetry of optic chiasma, but within normal range. However, long-standing cases will definitely show significant changes in measurements of chiasma.

True coronal T2WI sequence should be properly planned on axial image so as to demonstrate chiasma. Inaccurate measurements are the result of oblique imaging of chiasma as noted in one case (Table 2).

A very rare case of optic chiasmal aplasia⁽¹⁴⁾ was seen at another hospital in which there was complete nonvisualisation of optic chiasma with unilateral anophthalmos and nearly absent ipsilateral optic nerve. This abnormality is different from non-decussating retinal fugal fibre syndrome and albinism.⁽¹⁵⁾ In chiasmal aplasia, the optic chiasma is very difficult to identify due to congenital absence or marked hypoplasia. The chiasmal region is nearly filled up with CSF signal intensity. There was no associated cerebral malformations.

A rare aetiology like chronic chiasmal arachnoiditis can only be suspected by alteration in dimensions of optic chiasma where presence of fibrous cicatricial bands causes chiasmal compression.⁽¹⁶⁾ However, chiasmal neuritis⁽¹⁷⁾ resulting from aetiologies ranging from idiopathic, demyelinating disease,^(17,18) infections, etc. cannot be confirmed by chiasmal measurements. In case of optic neuritis, gadolinium enhancement of optic nerve and chiasma is characteristic finding in appropriate clinical setting. As well as, Acute Ischaemic Optic Neuropathy requires other imaging techniques such as diffusion imaging studies, which shows hyperintense lesion.⁽¹⁹⁾

CONCLUSION: This study highlights the usefulness of evaluating optic chiasma and chiasmal-perichiasmal lesions including aetiologies of chiasmal syndrome^(20,21) and rare congenital abnormality. Objective measurements of optic chiasma should be done routinely in T2WI coronal images. However, there are few very lesions that cannot be seen on this routine MRI study. Our study demonstrates the normal measurements of chiasma and significant deviation are suggestive of chiasmal lesions at a much earlier stage. This

is definitely helpful in prompt management and better prognosis.

ABBREVIATION:

MRI = Magnetic resonance imaging.

PACS = Picture archiving and communication system.

T2WI = T2 weighted imaging.

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