

The Occipito-Hypothalamic Interconnection Fiber Within the Fornix: (The First Report)

Kriengkrai Urusopon, M.D., Umphaphorn Phornkunnatham, M.Sc., Jantima Roongruangchai, D.D.S., Ph.D.

Department of Anatomy, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok 10700, Thailand.

ABSTRACT

Objective: To demonstrate the occipital crus of the fornix from the brain of Thai cadavers and provide here the first finding and the first report.

Methods: 10 brains of Thai cadavers, 5 males and 5 females, were bisected. Each half was further dissected to demonstrate the inferior horn, the body and the collateral trigone of the lateral ventricle by removing the cerebrum from the superior part down and backwards. The dissection also removed the body of the corpus callosum and left only the splenium portion. When exposing the inferior horn and the collateral trigone, the hippocampal formation was situated at the inferomedial aspect. We can see the fornix arises from the fimbria of the hippocampus and curves anteriorly to terminate at the mammillary body and the septal nuclei. Another 15 sets of horizontal brain sections and 15 sets of coronal brain sections also helped in confirming this report. The sections passed through the crus of the fornix were selected and observed.

Results: We can define and demonstrate another crus of the fornix, which arises from the occipital lobe of the brain, the occipital crus. This crus may arrange in a round elevated bundle or a flat bundle beneath the ependyma and join the posterior part of the hippocampal crus of the fornix at the medial border of the body of the lateral ventricle.

Conclusion: The fornix is the fiber which originates from the hippocampal formation to be the fimbria and leaves the hippocampus as the crus part of the fornix. Then it curves superiorly anteriorly and inferiorly to terminate at the septal nuclei and the mammillary body. Another crus of the fornix comes from the occipital cortex posteriorly and joins together with the hippocampal crus to terminate in the same area. This suggests that the occipital crus of the fornix involves in another part of the limbic structures that are responsible for the memory consolidation, emotions and autonomic responses.

Keywords: Fornix; hypothalamus; occipital lobe

Siriraj Med J 2008;60:126-129

E-journal: <http://www.sirirajmedj.com>

From the hippocampal gyrus and the cornu ammonis, fibers enter the fimbria¹. The origin of many fibers of the fimbria – fornix complex from regions other than the hippocampus and hippocampal gyrus was evidenced for man from a study of cases of bilateral injury of the hippocampus². In one case with serious bilateral injury of the hippocampus and complete destruction of the fusiform and the hippocampal gyri, a considerable number of the fornix fibers were intact (for about 25 percent not degenerated)². The fimbria parallels the hippocampus throughout its extent. As the splenium of the corpus callosum is approached and the main mass of the hippocampus disappears, the bundles constituting the fimbria continue in four directions³.

Firstly, a few of the fibers of the fimbria, accompanied by hippocampal gray known as fasciola cinerea extend over the splenium of the corpus callosum and forward as a white stria of Lancisi (fornix superior or fornix dorsalis).

Secondly, a large component of the fimbria continues through the hippocampal commissure to distribute to the cornu ammonis and possibly even to reach the entorhinal area of the other side^{4,5}.

Thirdly, the component of the fimbria is formed by fibers (such as septohippocampal) afferent to hippocampus and the hippocampal gyrus³.

The fourth component of the fimbria continues forward without synapse to constitute the fornix. Within the body of the fornix some of the fibers cross to distribute contralaterally. The main mass of the fornix fibers extends forward along the lower border of the septum pellucidum. It arches above and then in

Correspondence to: Jantima Roongruangchai
E-mail: www.headsian@mahidol.ac.th

front of the interventricular foramen to approach the region of the anterior commissure. Here the fornix splits into two parts. A small precommissural portion passes down in front of the anterior commissure to the medial septal nucleus, preoptic and anterior hypothalamic areas. The postcommissural fiber of the fornix projects to the mammillary body¹. The bilateral section of the fornix in man has produced no obvious defects.

Recent studies have indicated that visual and tactile impulses can be picked up from the hippocampus¹, although the pathway by which they might be mediated, except possibly those described by Cajal, between the visual association area and hippocampus, are not well known. Presumably they are by way of the alveus. The alveus is a thin medullary substance of intraventricular portion of cornu ammonis (hippocampus). It is the fiber from the subiculum and cornu ammonis (hippocampus) of hippocampal gyrus. It becomes approximate to the fimbria. The alveus and fimbria form the posterior crus of the fornix⁶⁻⁹. The crura of the fornix are prolonged backwards from the body. They are flattened bands, and at their commencement are intimately connected with the under surface of the corpus callosum¹¹.

The hippocampal formation plays a role in memory consolidation. The pathway from the hippocampal formation through the hypothalamus and back to the cingulate gyrus is the circuit postulated by Papez and plays a role in emotion. It is now known that the Papez circuit plays a more important role in memory than emotion¹⁰.

In this study we found a new connection to the fornix at the crus region which comes from the occipital cortex by dissecting the cadaveric brains and confirmed by brain blocks of both coronal and horizontal section. All of the cases show these pathway fibers but there has been no report before. This, therefore, is the first report of the occipito-hypothalamic interconnection fiber within the fornix.

MATERIALS AND METHODS

10 Thai cadaveric brains, 5 males and 5 females were bisected. Each half was further dissected to demonstrate the inferior horn, the body and the collateral trigone of the lateral ventricle by the following processes :

1. Remove the superior part of the brain over the level of the corpus callosum using the callosal sulcus as a guideline.
2. Remove the body of the corpus callosum.
3. The splenium of the corpus callosum was left remaining.
4. Remove the roof of the inferior horn of the lateral ventricle until the inferior horn can be seen throughout joining the collateral trigone.

After dissecting, we can see the hippocampus situated at the inferomedial aspect of the inferior horn. The fimbria parallels the hippocampus throughout its extent. As the splenium of the corpus callosum is approached and the main mass of the hippocampus disappears, the bundles continue from the fimbria which is the fornix and mostly arches at the inferior border of the septum pellucidum to the anterior commissure and ends in the septal nuclei and the mammillary body.

Another 15 sets of horizontal brain sections and 15

sets of coronal brain sections also helped in confirming this report that the sections passed through the region of the crus of the fornix which were selected to compare with the dissected cadaveric brain.

RESULTS

Fig 1 and 2 are the photographs of the dissected cadaveric brains. The fimbria parallels the hippocampus throughout its extent. At the splenium of the corpus callosum the main mass of the hippocampus disappears, the bundles constituting the fimbria continue in four directions³. The main and most clearly seen component of the fimbria continues forward to be the crus of the fornix. Then it arches above the lower border of the septum pellucidum to reach the interventricular foramen, and the anterior commissure. At this area the fornix splits to terminate at the septal nuclei and the mammillary body.

At the splenium of the corpus callosum where the fimbria continues forward to be the crus of the fornix, which we call here the hippocampal crus, we can see clearly the fiber from the occipital cortex joins the hippocampal crus, which we call here the occipital crus. The occipital crus is also subependymal white matter which can be seen clearly when carefully dissected out of the ependyma above the fornix. The occipital crus joins and travels together with the hippocampal crus to terminate at the septal nuclei and mostly mammillary body. Therefore it can be named the occipito-hypothalamic interconnection fiber within the fornix.

The occipital crus can be divided into two types, firstly, 18 in 20 cases of cadaveric brain, we cannot see the fiber until the ependyma was removed. The occipital fibers do not form a bundle but separately enter the fornix. Secondly, 2 in 20 cases of cadaveric brain, the occipital crus (Fig 1, 2) formed an elevated prominent bundle before joining the hippocampal crus, and can be seen even if the ependyma is not removed. The occipital fibers come from the occipital lobe, they course forwards and medially to the roof of the collateral trigone and roof of the posterior part of the body of the lateral ventricle. It lies dorsomedial to the hippocampal crus and join together at the body of the fornix.

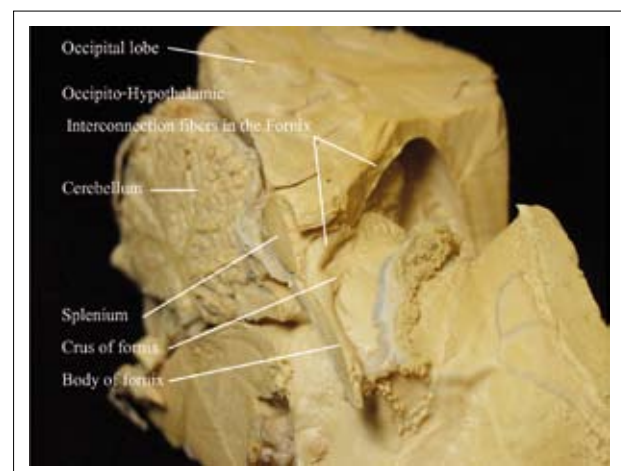


Fig 1. Half brain dissection, demonstrates the superior view of the fornix which composed of 2 crura, the hippocampal crus and the occipital crus. Both join together and continue to be the body of the fornix.

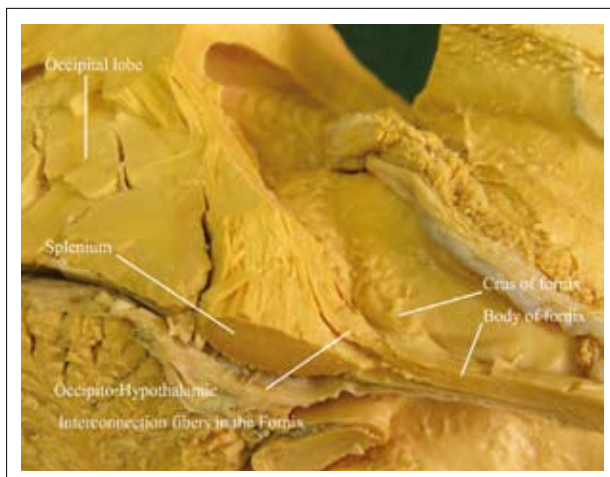


Fig 2. Superior view of the brain dissection after removal of the ependyma from the occipital crus and clearly see the occipito–hypothalamic fiber

DISCUSSION

The occipital crus of the fornix, type one or type two, comes from areas 17, 18, 19 of the occipital lobe which indicates that the process sensory information of vision has some influences to the Papez's circuit. This is very essential to the learning process, memory consolidation and also influences the thalamus and is followed by ANS responses.

Fibers from the occipital lobe pass forwards and medially at the roof of the collateral trigone and posterior part of the body of the lateral ventricle. The fibers elevate prominently into the body of the lateral ventricle before joining the hippocampal crus of the fornix. This indicates that the occipital lobe gives both projection fibers and commissural fibers. The commissural fibers are part of the corpus callosum and the projection fibers are the occipital crus to terminate at the septal nuclei and the mammillary body.

From the dissection of the cadaveric brains, mostly the occipital crus does not form a bundle but separately enters the hippocampal crus (18 in 20 cases), this can answer the question of why there is no report about the occipital crus. However, we found 2 of the 20 cases of

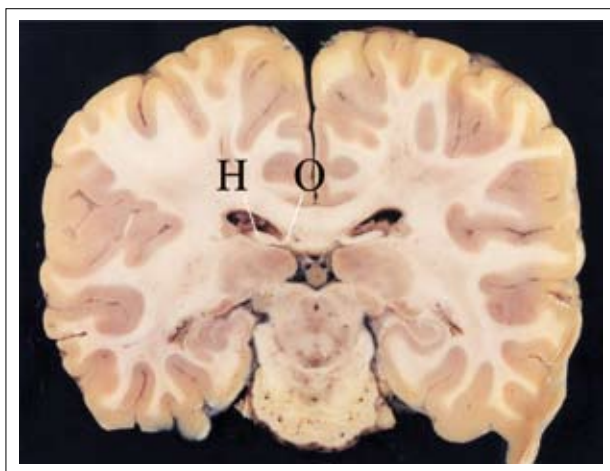


Fig 4. The coronal brain section, the block passed the crus of fornix, which can be divided into the hippocampal crus (H) and the occipital crus (O).

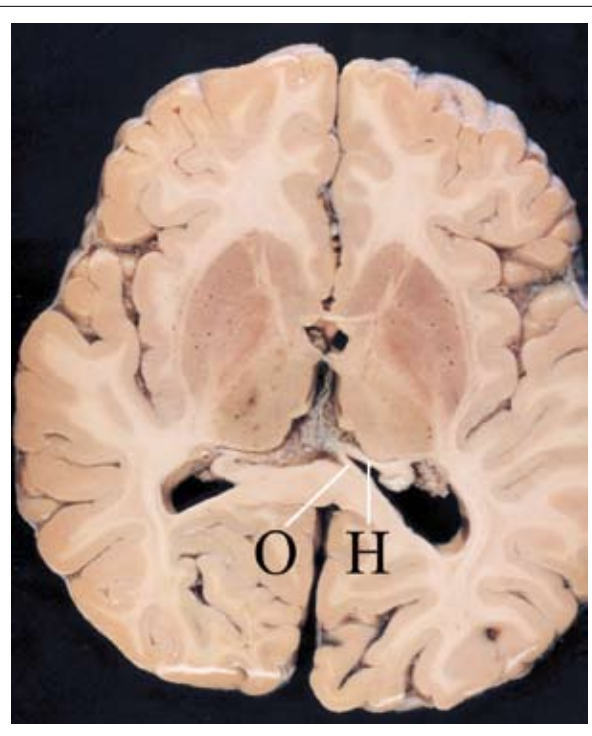


Fig 3. The horizontal brain section, the block passed the crus of fornix, which can be divided into the hippocampal crus (H) and the occipital crus (O).

the dissection in which the occipital crus formed a prominent bundle before joining the hippocampal crus at the inferior surface of the splenium and dorsomedial to the hippocampal crus. Both crura join as a V-shaped fiber bundle at the medial side of the posterior part of the body of the lateral ventricle.

This brings about the essential confirmation. We used 15 sets of horizontal brain sections and 15 sets of coronal brain sections to confirm if there is an occipital crus. We selected the sections which pass through the crus of the fornix. The coronal section reveals clearly the V-shaped fiber, the medial fibers of the letter V is the occipital crus of the fornix which is situated just inferior to the splenium. The lateral fibers of the letter V are the hippocampal crus of the fornix situated superior to the thalamus. The horizontal section of the brain reveals the two crura join at the body of the fornix to form the inverted V-shape, situated at the medial side of the posterior part of the body of the lateral ventricle. The medial fibers of the inverted V are the occipital crus of the fornix which closely contacts to the splenium and the fiber continues posteriorly to the occipital lobe (Fig 3,4).

CONCLUSION

This is the first report to demonstrate the occipital crus of the fornix by dissecting Thai cadaveric brains and confirmed by coronal and horizontal sections of the brain. The previous description of the fornix is the fiber continues from the fimbria of the hippocampus, arches above in the inferior border of the septum pellucidum to reach the anterior commissure. In termination, it splits to terminate in the septal nuclei and the mammillary body of the hypothalamus. In this careful study we found the fibers from the occipital cortex project and

join together to the crus of the fornix and we named it the occipital crus while the crus from the fimbria of the hippocampus is named the hippocampal crus. This indicates clearly that direct fibers from the occipital cortex terminate in the septal nuclei and mammillary body. Therefore, these fibers are concerned with the limbic system. This suggests that vision is essential for memory consolidation, since vision can cause emotions and autonomic responses.

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