International Journal of Anatomy and Research,
Int J Anat Res 2018, Vol 6(1.3):5041-45. ISSN 2321-4287
DOI: https://dx.doi.org/10.16965/ijar.2018.110

Original Research Article

KLINGLER'S FIBER DISSECTION METHOD- AN ASSISTING APPROACH TOWARDS TEACHING NEUROANATOMY

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ABSTRACT

Background and Objective: The Klingler fiber dissection technique is a simple and less complicated method for identifying the fine structure of the white fiber tracts of brain. In this study, we have used classical fiber dissection technique by Klinger's to produce white matter specimens which can be used for explaining anatomy of various white matter tracts to students.

Materials and Methods: Five brains specimen removed from formalin fixed human cadavers (3 males and 2 female) were used in this study. Klinger's fibers dissection method was used to obtain white fibers specimen. Dissection of the cerebrum was performed using wooden spatulas, fine curved metal spatulas, fine forceps. The white fibers were exposed by peeling brain with help of wooden spatula to expose the fibers. The dissection microscope was used to isolate small structures.

Results: Using the classical Klinger's technique, we were able to obtain a brain specimen depicting organization of various white fibres such as corona radiata, superior longitudinal bundle, association fibres with fibres passing in relation to lentiform nucleus. In another specimen, dissection of right cerebral hemisphere medial to lentiform nucleus showed continuity of white projection fibres of corona radiata as internal capsule. Fibres of corpus callosum were delineated in two specimens which displayed spatial disposition of its various parts.

Conclusion: White matter fiber of brain are very important for understanding of function of the central nervous system function. The Klingler's fiber dissection technique with other study material can successfully serve the purpose of the teaching of complex brain architecture of white matter. These dissected specimens will be more attractive to students, than the mere imagination of white fiber tracts during neuroanatomy classes.

KEY WORDS: Corona radiate, Fiber dissection; Klingler technique, Lentiform nucleus, Corpus callosum.

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Access this Article online	Journal Information
Quick Response code	International Journal of Anatomy and Research
	ICV for 2016 90.30
	ISSN (E) 2321-4287 | ISSN (P) 2321-8967
	https://www.ijmhr.org/ijar.htm
	DOI-Prefix: https://dx.doi.org/10.16965/ijar
DOI: 10.16965/ijar.2018.107	

Article Information

Received: 04 Jan 2018	Accepted: 03 Feb 2018
Peer Review: 04 Jan 2018	Published (O): 05 Mar 2018
Revised: None	Published (P): 05 Mar 2018

INTRODUCTION

The white matter anatomy of the brain is relevant for medical students and also for practising doctors. Understanding the anatomy of white matter fibres is not only important academically but also clinically and for management of neurological disorders [1].

A technique of well-defined preservation and dissection was developed by Professor Josef Klingler (1888–1963) at the University of Basel in the 1935. It was used to isolate complete fibre pathways by removing parts of the cortex and underlying white matter of formalin-fixed brains [2-4].

The anatomical data provided by newer imaging MRI techniques and DTI tractography are excellent for the clinical and surgical understanding. However for first year undergraduate medical students dissection of brain specimen is necessary since it gives the students direct visual information [5].

Although dissection remains the best traditional method to teach anatomy, but due to paucity of cadavers and time constraints it is often unfeasible to teach through every student with hands-on training [6]. Also, gross anatomy or sectional anatomy often have lacunae in representing the complex three dimensional relationships of various brain structures [7].

White matter damage has been seen in many of neurological and psychiatric diseases, such as Stroke, Alzheimer's disease, Multiple sclerosis and Schizophrenia [8,9]. The neurosurgeons and radiologists have already been using fiber tracking for perioperative and the evaluation and management of brain tumors [10].

In this study, we have used classical fiber dissection technique by Klinger's to obtain white matter specimens which can be used to explain in detail three dimension anatomy of white matter fibers within cerebrum.

MATERIALS AND METHODS

Five brain specimen removed from formalin fixed human cadavers (3 males and 2 female) were included in this study conducted in the Department of Anatomy, Maulana Azad Medical College, New Delhi. All Cadavers were without any history of neuropathological diseases in their clinical records. After removal of the dura mater, brains were fixed in 10% formalin solution at room temperature for two months after which the Klinger's protocol was followed as described below.

Steps

Klinger's method: After the fixation period, brains were washed in running water for one night .The remaining arachnoid and pia mater and vessels were removed. Brains were placed in fresh 10% formalin solution. The specimens were then stored in a refrigerator at -10 to -20^{o} C for 8–10 days. Afterward, the brains were thawed in running water for one day, then stored in the refrigerator once more for 8–10 days at -10 to -20^{o} C. Finally, the brains were thawed in running water for one day before dissection.

Dissection: Before dissection, the surface anatomy of the sulci and gyri of the cerebrum was studied in detail as to help in the dissection .Meticulous dissection of the cerebrum was performed using wooden spatulas, fine curved metal spatulas, fine forceps . The white fibers were exposed by peeling brain with help of wooden spatula to expose the fibers. The dissection microscope was used to isolate small structures. Brain specimens were stored in fresh 10% formalin at room temperature in between dissection procedures.

OBSERVATIONS AND RESULTS

Fig. 1: Dissection of superolateral surface of right cerebral hemisphere depicting various white fibres labelled as corona radiata, superior longitudinal bundle, association fibres. [* Fibres passing in relation to lentiform nucleus.]

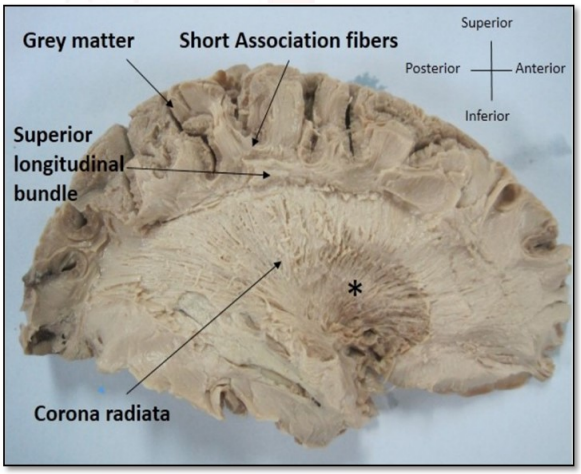


Fig. 2: Dissection of right cerebral hemisphere medial to lentiform nucleus showing continuity of white projection fibres of corona radiata as internal capsule (within oval box). Fibres from various lobes of cerebrum can be seen radiating in a fan shaped manner.

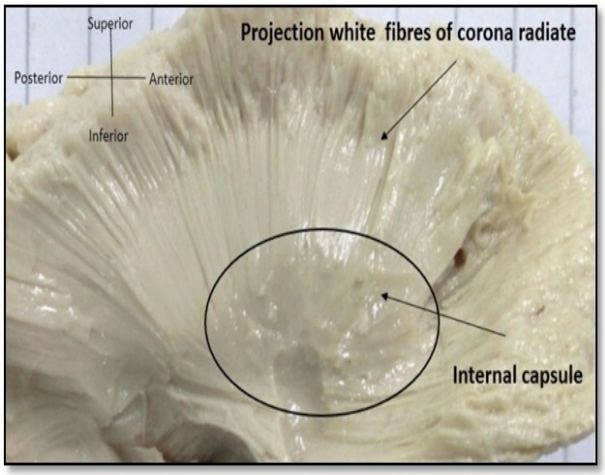


Fig. 3a: Dissection of commissural fibres (superior view), various components of Corpus callosum are delineated. to lateral ventricle (*) is discernible.

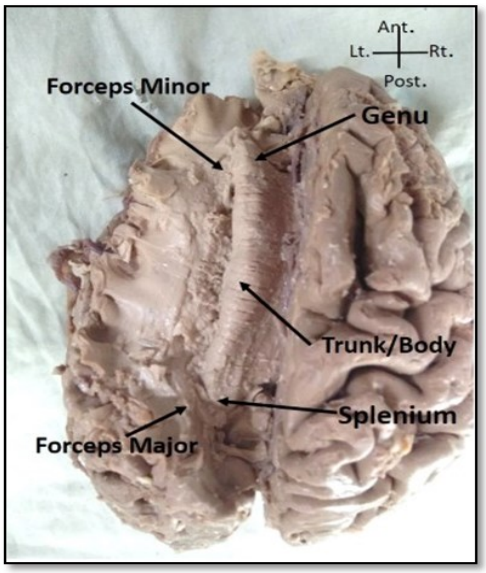
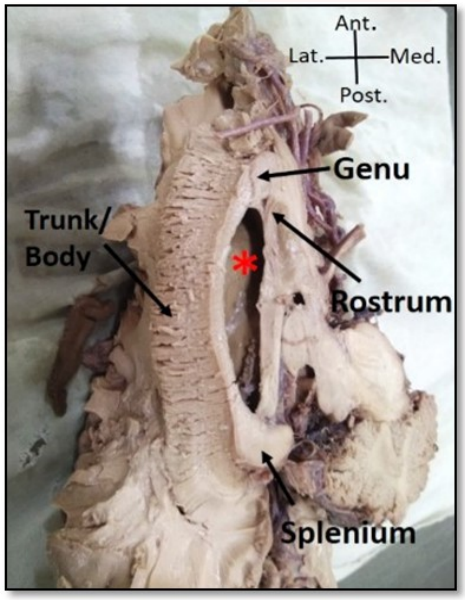


Fig. 3b: Spatial placement of corpus callosum (superomedial view) in sagittal section of cerebrum. Its Relative disposition to lateral ventricle (*) is discernible.



The dissection of the brain specimens was completed in three weeks. As the dissection was carried out by senior experts under the guidance of experienced professor, it took approximately 9-10 hours to dissect one brain specimen. Based on the anatomy of various fibers described in standard tectbooks, each specimen was dissected from different aspects so as to obtain all types of major fibres traversing through the cerebrum. On dissection of superolateral surface of right cerebral hemisphere various white fibres were seen. The pathway of projection fibers of corona radiate was clearly visible. The continuity of these fibers/tract as a component of internal capsule in relation to lentiform nucleus was deciphered. Other types of fibers viz., superior longitudinal bundle, association fibres were also observed as shown in Figure 1. In another specimen , dissection of right cerebral hemisphere was done medial to lentiform nucleus which showed the continuity of white projection fibres of corona radiata as internal capsule as shown in Figure 2. Fibres from various lobes of cerebrum can be also be seen radiating in a fan shaped manner. For specimen of commissural fibres dissection for observing the placement of corpus callosum was done from superior aspect of cerebrum. The various components of Corpus callosum were delineated as seen in Figure 3a &3b.

DISCUSSION

The proper anatomical knowledge of the configuration of brain is required for the neurosurgeons to perform various neurosurgical procedures. With recent advances, such as DTI and other imaging techniques it has become easier to study white matter fibers. But these techniques are not equivalent to the direct visualization of specimen of brain [11].

The traditional brain specimens in learning neuroanatomy cannot be replaced by the computer-based resources. The computer-based learning modules can have beneficial effect on learning outcomes. But they have some disadvantages like cost and technical problems. The proposed fiber dissection technique can allow visualization of the tracts, their anatomical variations and could provide a learning experience that leads to detailed understanding of white matter anatomy. Still the classical approach for teaching neuroanatomy is based on cadaver dissections or sectional anatomy [12].

In this study, we have used the classical fiber dissection technique proposed by Klinger to obtain simple and easy to use white matter specimens that do not require special instruments or settings. These brain specimens can be used as a tool in teaching white matter anatomy. White matter of brain is a complex architecture in human. But in regular formalin-fixed specimens of brains, the white matter appears homogenous, so we cannot demonstrate individual tracts and their origin, course and termination [13,14]. During fixing of brain the formalin penetration

of myelinated nerve fibers is very poor and it remains between the fibers. This forms the basis of freezing the brain specimen before dissection. After freezing the formalin expands in between nerve fibers and it separates these fibers and facilitates the dissection of white fibers.The alternate freezing and thawing allows easier separation during dissection of the white matter of brain and distinction of the fascicles and tracts . After freezing, the ice crystals formed causes expansion and separation of the fibers. But the main reason for easier dissection of brain fibers was demonstrated by Zemmoura et al in 2015. In their study they showed that inter-myelin bridges are destroyed and interaxonal lacunae are formed, which facilitates the dissection of fiber bundles. The Klingler technique facilitates dissection of white matter fibers with the preservation of the axons and myelin sheaths but alters the extracellular matrix [2,15,16].

White fiber dissection is a simple technique but some problems are encountered during dissection. The fibers are delicate and break easily, which can lead to an artefact. Also the fiber crossings can be major problem in the fiber dissection. If the dissection is not done properly then irreversible damage to the specimen can lead to wasting of brain specimen. Therefore, it is important that the dissection is done by experienced anatomists having in depth knowledge of human neuroanatomy [14].

The described cost-effective and easily reproducible technique by Klinger should be routinely incorporated to give detailed knowledge of white matter fiber of brain.

CONCLUSION

The structural organization of white matter fiber of brain should be known for understanding of function of the central nervous system. The fiber dissection technique with other study material can successfully serve the purpose of teaching of complex brain architecture of white matter. Dissected specimen of brain have more advantage than textbook or atlas for medical students. These dissected specimens will be more attractive to students, than the mere imagination of white fiber tracts during routine neuroanatomy teaching.

Conflicts of Interests: None

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How to cite this article:

Sachin patil, Madhu sethi, Sabita Mishra. KLINGLER'S FIBER DISSECTION METHOD- AN ASSISTING APPROACH TOWARDS TEACHING NEUROANATOMY. Int J Anat Res 2018;6(1.3):5041-5045. **DOI:** 10.16965/ijar.2018.110