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How to Prepare Brain Specimen for White Fiber Dissection: An Illustrative Guide

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Abstract

Background White fiber dissection is a method in acquiring in-depth neuroanatomical understanding for surgical practice. Collection of brain specimen during autopsy and preparation of the brain specimen without any disruption in anatomy are essential steps as cadaveric brain dissection is an important part of neuroanatomical teaching, and it further provides an initiative of how kind and precise the dissection must be during live surgery.

Objective The aim of the study was to explain the stepwise technique of the preparation of the brain specimen for white fiber dissection as relevant to neuroanatomical and neurosurgical teaching.

Materials and Methods The brain removal procedure is performed on the human brain during the conventional autopsy process.

Results Various consecutive and typical steps are recommended for the removal and preparation of the specimen. Photographs accompany each relevant step for better understanding of the procedure.

Conclusion In this article, we describe the technique and step-by-step guidelines to effectively remove the brain and to prepare the brain specimen for white fiber dissection. Avoiding common errors during this intricate procedure saves time and brain specimens.

Keywords
- brain removal
- brain specimen
- Klingler's technique
- white fiber dissection
- white matter anatomy

Introduction

The origin of white fiber dissection technique and its inclusion into the neurosurgical practice highlight how detailed and comprehensive anatomical knowledge helps the neurosurgeon to efficiently navigate the operating theater.[1] Just as cranial cadaveric dissection results in improved skull base surgeries,[2,3] brain surgery has been refined through the anatomical knowledge provided with the help of white fiber dissection techniques.[4–8] White fiber dissection helps the neurosurgeons get a three-dimensional anatomical knowledge for surgical practice. Postmortem brain tissues and specimens are crucial for advancing the field of neuroscience to pursue various therapeutic and diagnostic goals. However, current literature lacks a complete, comprehensive, and stepwise guidelines to effectively remove the brain during autopsy to get the brain specimens. Therefore, our primary objective is to describe the detailed and consecutive dissection steps involved in preparing the brain specimen for white fiber dissection.

Steps for Specimen Preparation

1. The cadaver must be placed in the supine position and the cadaveric head must be placed with the help of a wooden block at an angle of 45 to 60 degrees above the horizontal plane (►**Fig. 1**).

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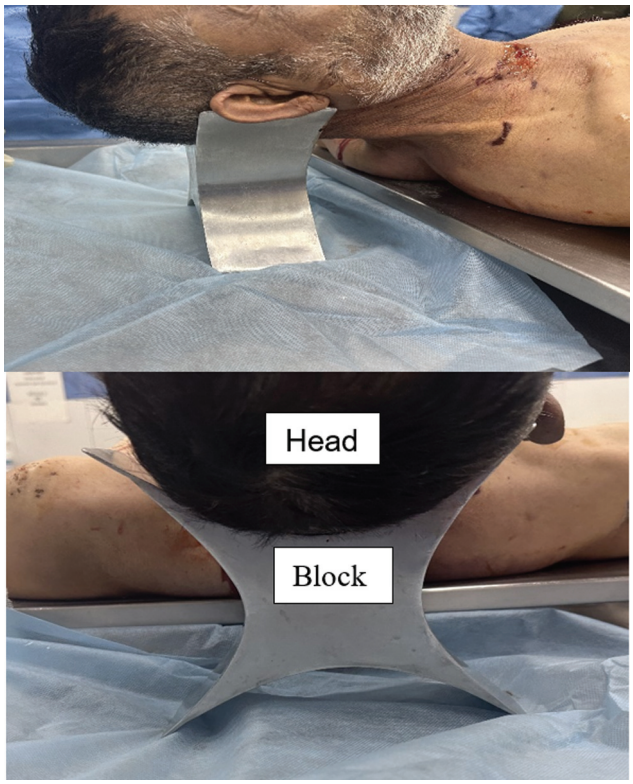

Fig. 1 Lateral and superior photographs showing a cadaver placed in dorsal recumbency, with a block supporting the head to maintain an angle of at least 45 degrees with the horizontal plane.

2. Unfixed cadaveric head will be opened during the conventional autopsy procedure within 12 to 48 hours after death to avoid tissue deterioration.
3. Perform a coronal incision in the scalp using a scalpel from the top of one ear to the top of the other ear (►**Fig. 2**).
4. Separate the subcutaneous fascial attachments with a scalpel and retract the scalp anteriorly toward the eyes and nose and posteriorly below the occipital protuberance (►**Fig. 3**).
5. The temporalis muscle must be cut bilaterally and then reflected inferiorly (►**Fig. 4**).

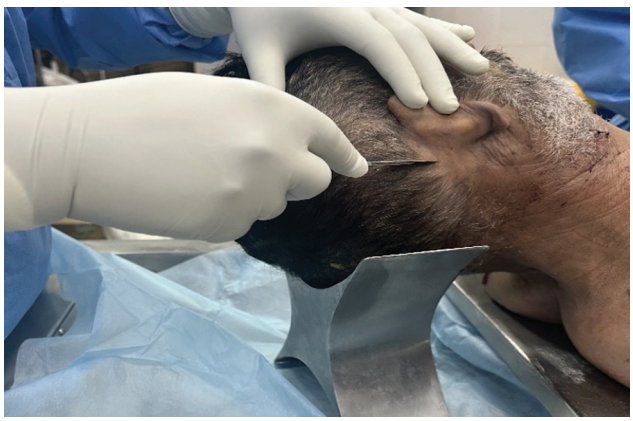

Fig. 2 Photograph showing the coronal incision in the scalp from mastoid to mastoid (one ear to the other).

Fig. 3 Photograph showing eversion of the scalp anteriorly toward the eyes and posteriorly toward the occipital protuberance.

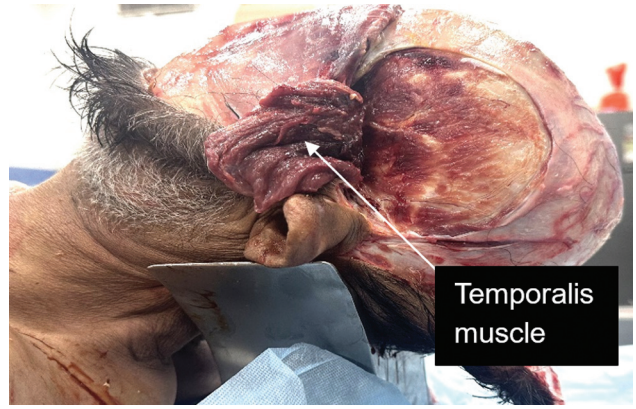

Fig. 4 Photograph showing the cutting of temporalis muscle and retracting it inferiorly.

6. After everting the scalp, cut through the skull using an electric saw. Be particularly careful not to cut too deeply to avoid damaging the cortex (►**Fig. 5**).
7. Use the skull breaker or chisel to break the inner lamina of the skull.
8. Remove the dura from the skull cap with the help of curved incisors and keep the skull cap apart. Separate the dura in the longitudinal fissure using blunt dissection (►**Fig. 6**).

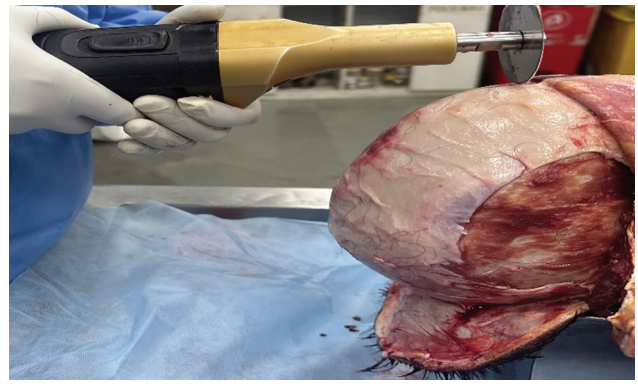

Fig. 5 Photograph showing the cutting of the skull using an electric saw.

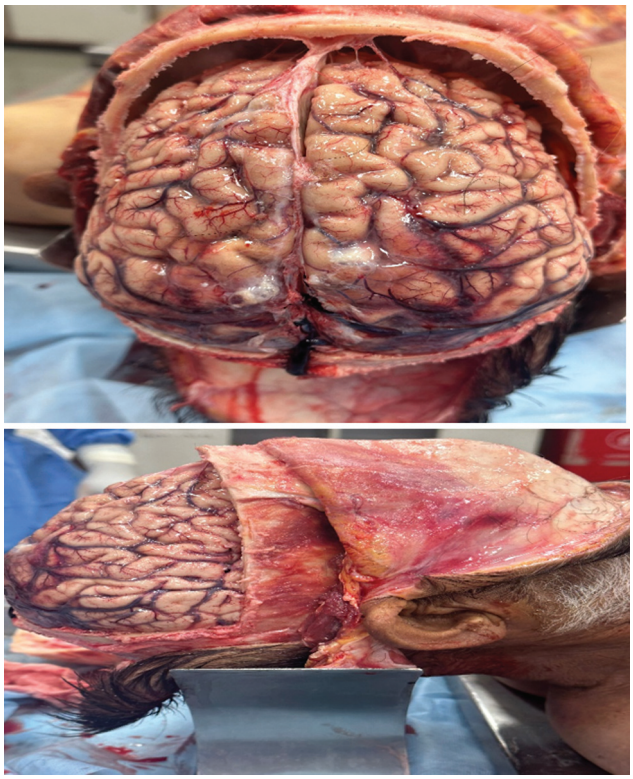

Fig. 6 Photograph showing the brain after removal of the calvaria.

9. Cut the dura mater around the cerebellum and expose the spinal cord by pulling the cerebellum forward (►**Fig. 7**).
10. Reach toward the foramen magnum and transect the spinal cord as distally as possible.
11. Transect the cranial nerves along with vessels using curved scissors.
12. Place the brain in a container or a bucket filled with buffered 10% formalin and hang it with the help of a thread tied with the circle of Willis and then use a gauze to protect it from deformation during the fixation process and cover the bucket after the entire process with a lid (►**Fig. 8**).
13. The brain is placed in this formalin solution for at least 4 weeks.

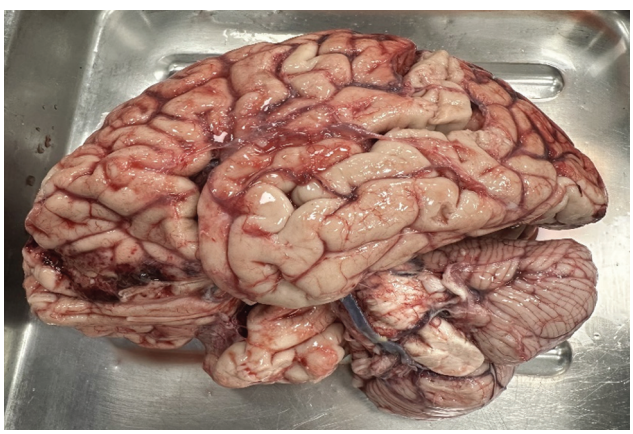

Fig. 7 Photograph showing the brain after cutting the spinal cord, cranial nerves, and vessels.

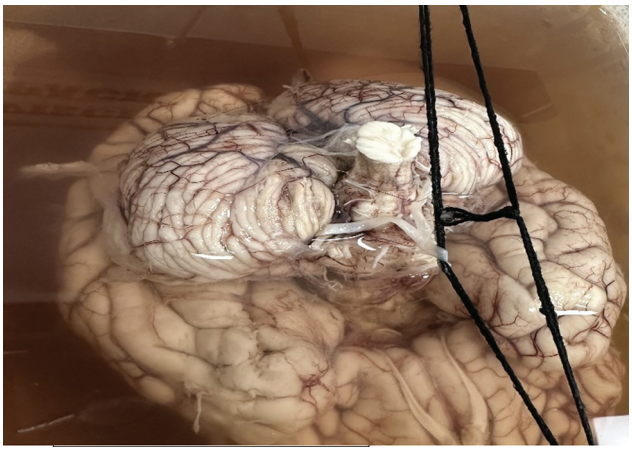

Fig. 8 Photograph showing the brain in a container or a bucket filled with formalin and hanging it with the help of a thread tied to the circle of Willis.

14. The specimens are then sent for freezing and refrigerated at –8 to –15°C for at least 8 to 10 days (►**Fig. 9**).
15. The last stage is thawing, where the specimens are thawed under running water, after which the specimen is ready for white fiber dissection.

Discussion

We attempt to provide a guide to remove and prepare the brain specimen in a simplified manner. Although there are several studies that define the procedure and have improved our understanding about the delicate fiber tract neuroanatomy, the literature does not provide the reader with a stepwise manual for the entire removal and preparation process. The present study further improves upon our understanding of the brain architecture and contributes to the refinement of the surgical approaches.

In Klingler's technique, the brain must be removed from the cadaver within 12 hours of death, but this time may vary from 8 to 18 hours in assorted studies.[9–13] In our study, we removed the brain within 12 hours of death to avoid autolysis. Klingler

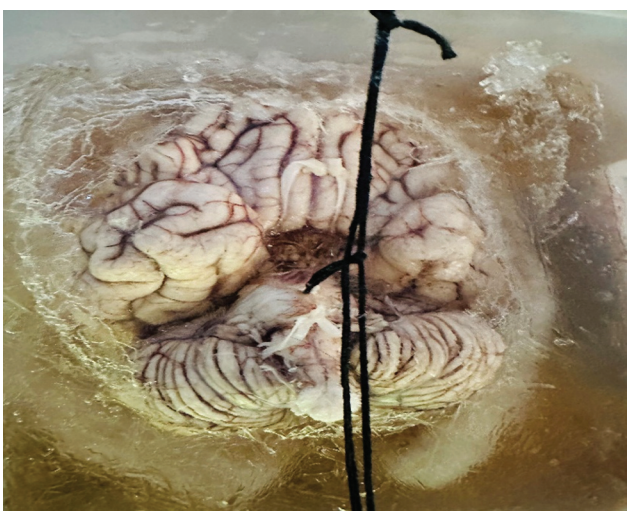

Fig. 9 Photograph showing the freezing stage where the specimen is frozen at –8 to –15°C.

also emphasized on the position of the head during brain removal. According to him, the head must be placed lower than the body to get a large amount of blood so that the gray matter and white matter could be easily differentiated in the presence of a large amount of blood. In numerous studies, brain fixation using formalin solution, which is injected intra-arterially, is done prior to brain removal.[9–13]

To prevent the unfixed brain from deformation after its removal, it is suspended from the basilar artery using a ligature to keep it floated in formalin, as supported by various authors.[1,11,14–18] However, in our technique, we suspend the brain using a ligature to the basilar artery and we place a gauze piece below it near the frontal poles to prevent it from deformation. To achieve adequate fixation, we keep the brain in formalin solution up to 4 weeks, as supported by various studies.[16] After 4 weeks of immersion, the arachnoid and blood vessels are removed.[5,9,11,14,17,19–27]

The brain is kept in the refrigerator with temperature varying from –8 to –15°C for at least 8 to 10 days.[28] Then we use the freezing and thawing technique, which allows greater penetration of the formalin solution within the myelinated nerve fibers.[15,29,30] Then the thawing step is done where we keep the brain under running water.[11,15,16,18,31,32] Now our brain specimen is ready for further processing of white fiber dissection.

Conclusion

White fiber dissection is a crucial method for gaining deep understanding of neuroanatomy. It is of utmost importance that we adopt the proper technique for brain removal and make it ready for dissection, as it will provide the surgeon with more clarity of the delicate neuroanatomical structures. When combined with various advance neuroimaging and functional studies, white fiber dissection can enhance the quality of micro-neurosurgical approaches and surgical care in patients.

Funding
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Conflict of Interest
None declared.

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