

En bloc Removal of Ligamentum Flavum: Butterfly Technique (Lumbar, Thoracic, and Cervical Decompression)

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Spine Specialty Hospital Accredited by the Ministry of Health and Welfare
DAEJEON WOORI HOSPITAL

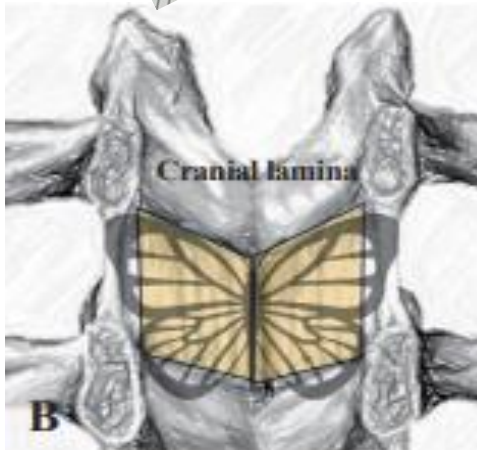


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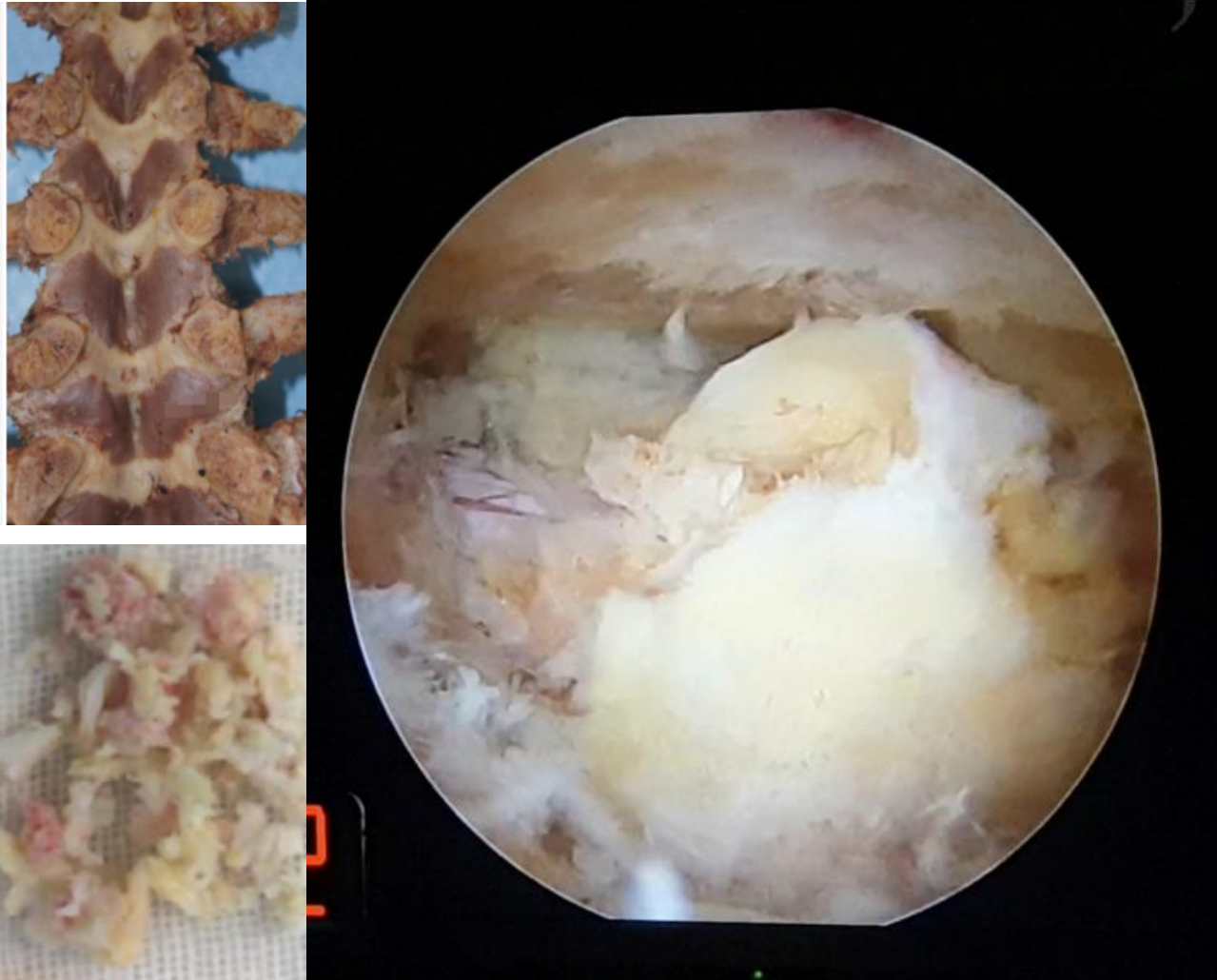
What is En bloc Removal of the Yellow Ligament?

- Overview of En Bloc LF Removal



- A technique for removing the Ligamentum Flavum (LF) in one piece (1 piece or 2–3 pieces)
- Delayed removal of Lig, flavum after full exposure of yellow ligament.

Importance of the Butterfly Technique



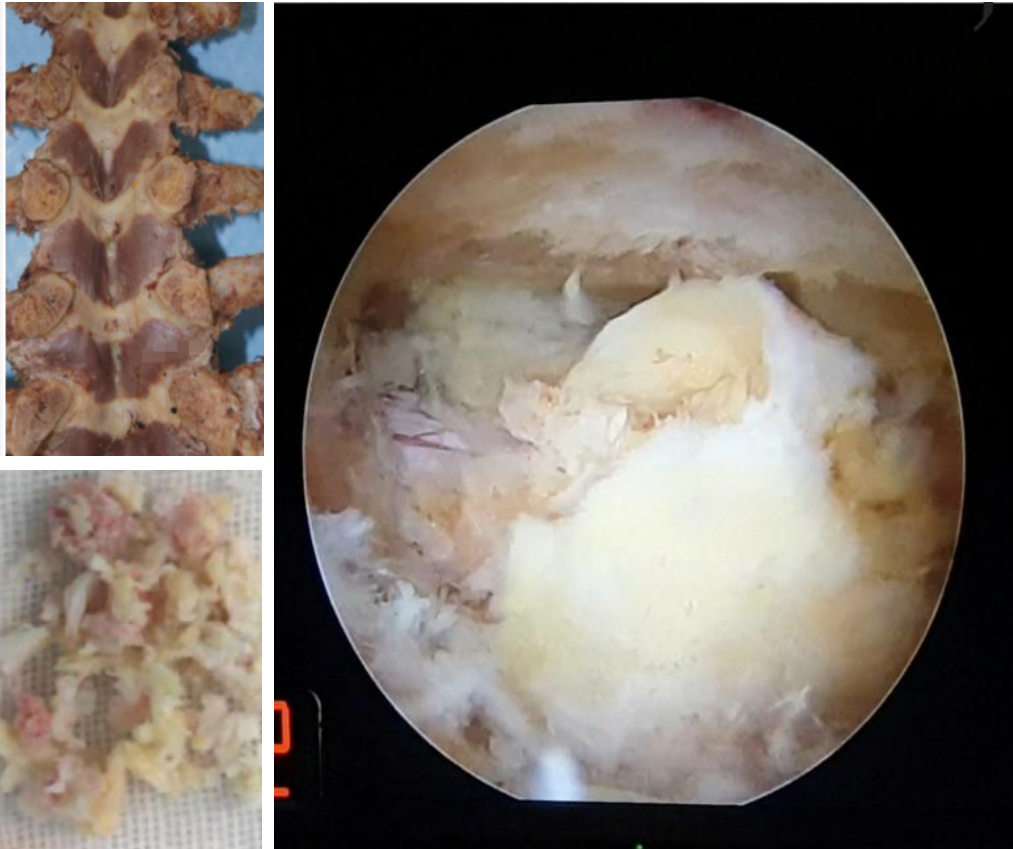
- Enhances safety and efficiency in decompression surgeries.
- Reduces risks associated with piecemeal removal.
- Nerve protection and minimally invasive approach available
- Avoid risk of dura injury especially when severe stenosis



Importance of the Butterfly Technique

- Biportal ESS is Water Based surgery

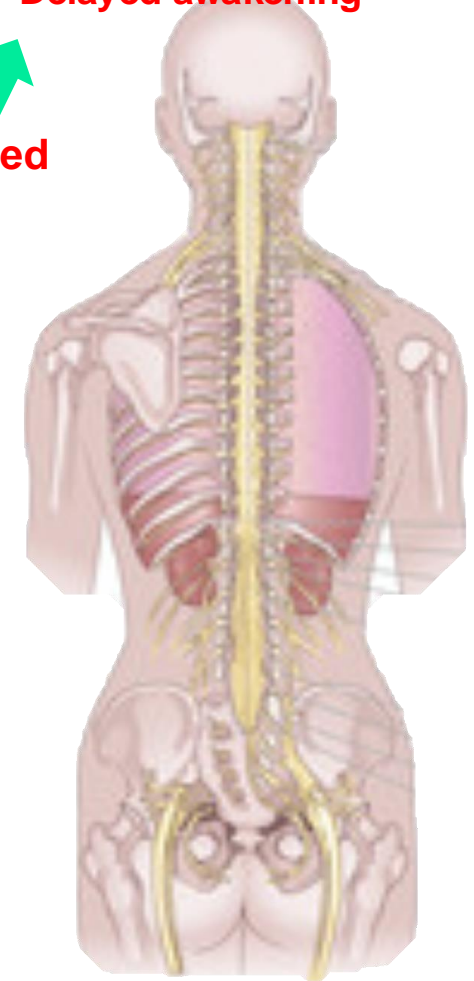
=> Need to Avoid any Early Dural Injury Prevent Increased ICP



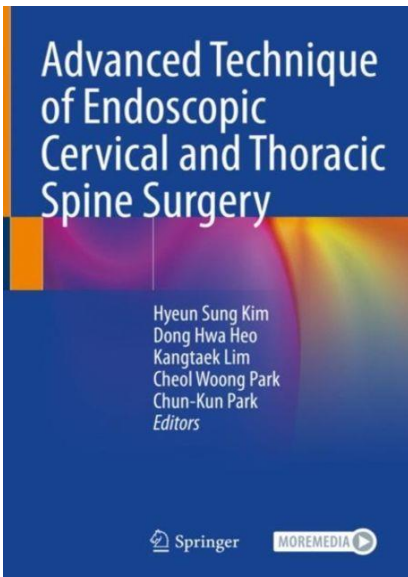
Fluid pressure
increases inside
the working
compartment

Increased
ICP

Headache
Neckache
Delayed awakening



Butterfly Technique's Rise



- In recent years, interest in “Butterfly technique” has been growing
- Many doctors are trying to the “Butterfly technique” challenge.
- “Butterfly technique” included in textbooks so that many people can study it.
- Dr. Butterfly Prize Award is being held.

Butterfly Technique's Rise

- Popularity on Facebook and ongoing challenges
- Widely adopted by surgeons worldwide



Butterfly Technique's Rise

- First to use the term “Butterfly Technique”
- Named to describe the symmetrical removal of the ligament, resembling butterfly wings.

Biportal endoscopic *en bloc* removal of the ligamentum flavum for spinal stenosis: nuances for the “butterfly” technique

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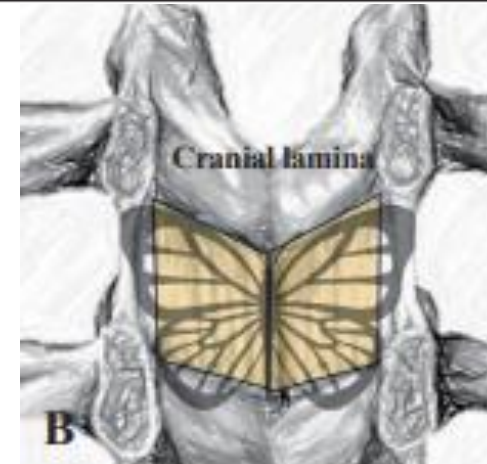
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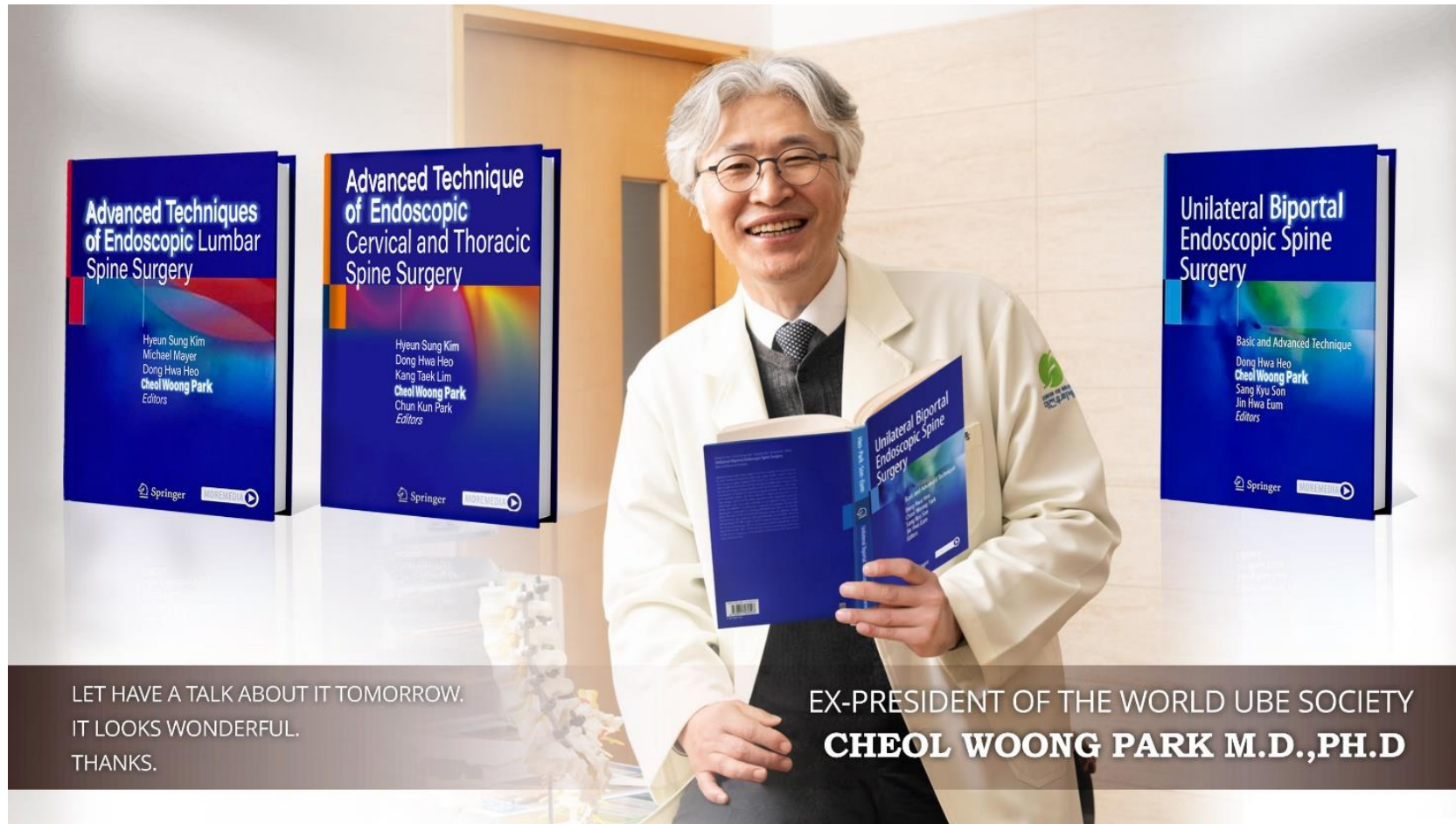
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My Contributions

- Technical notes and textbooks
- Published articles and textbooks detailing the method.



Preface

The endoscopic spine surgery (ESS) has brought a new paradigm in the surgical treatment of spinal disorders about 20 years ago. Since then, there has been a remarkable development in technologies and the biomedical researches that many different approaches and instruments have been developed and applied. This is due to our colleagues, who, as experts in their fields, have dedicated their time and resources in research and shared their knowledge and experiences with others.

The unilateral biportal endoscopic (UBE) spine surgery has recently applied in ESS as well. Despite some skepticism, it has shown remarkable results and improvement of patients' quality of life after the surgery with significant other pros. UBE has proven to be very effective in certain situations with less hospital stay and postoperative complications leading to increase in the number of UBE performed, becoming one of the significant treatment of choice in recent years. This calls for the need of UBE textbook for those who want to learn the UBE to incorporate in their practice.

This book may give basic scientific knowledge and surgical skills as it has incorporated the advanced biomedical research and clinical practice in the interim. I do believe that this book is a milestone in ESS and definitely becomes a guiding light to many. ESS itself is an innovation and UBE as well, and this won't be the last. This book will provide continuous education to not only those who are new but also with well-established practice and skills.

I am honored to be part of this monumental project and being given the opportunity to endorse the first edition of UBE textbook in the world while I could serve as the third president of UBE research institute of Korea. I wish to express my appreciation to the authors who have dedicated their time and efforts for this book. This book could not have been edited without the dedicated help of our editor-in-chief, Dr. Dong Hwa Heo. My great respect to the editor-in-chief. Thank you.

Daejeon, Republic of Korea

Cheol Woong Park



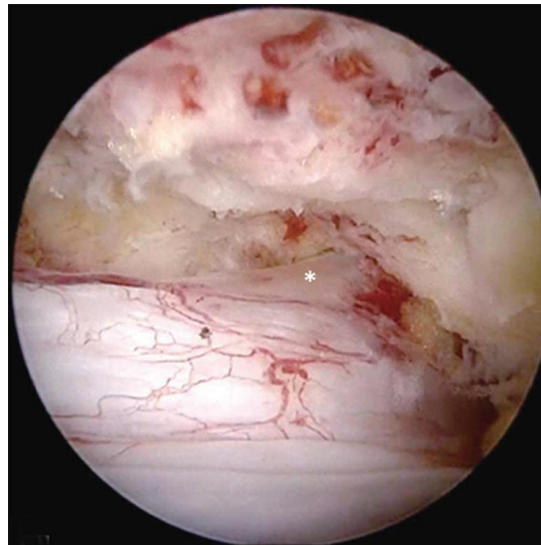
My Contributions

- **International Meeting of WUBES 2025**
April 25-26, Seoul
 - **Session : En Block Resection of Ligamentum Flavum**
From Cervical to Lumbar Area
Who is the best Butterfly Catcher in UBE?
 - **Dr. Butterfly Prize Award**
(By. Dr Cheol Wung Park, Daejeon Woori Hospital)
 - **Moderator : Dr. Cheol Wung Park**



Advantages of the Butterfly Technique

- Nerve protection
- Pressure control
- Reduced dural tear risk
- Minimal bleeding
- Faster surgery



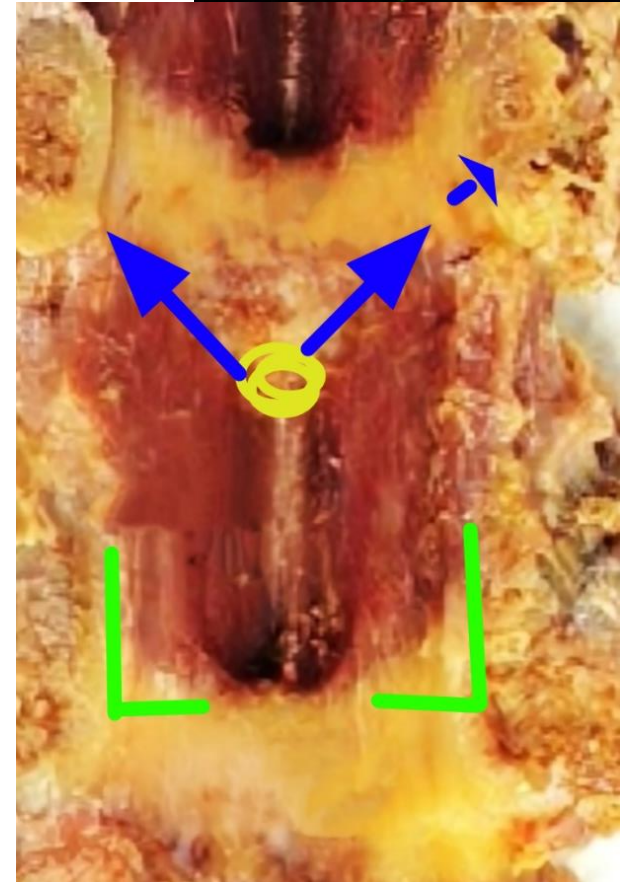
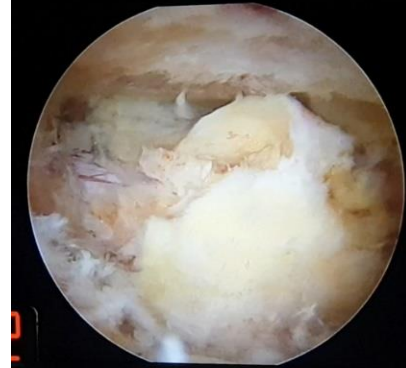
Importance of the Butterfly Technique

- **Merits**

- **Delayed removal of Lig.flavum**
 - ➔ Prevent early tearing of dura
 - Reduce epidural bleeding
 - Prevent Nerve damage by instrument
 - Delayed increase of epidural canal pressure
- Time save ; faster than piecemeal resection
- More safe with well visualized operation field
- Can expose bone margin clearly
- Can nearly full decompression, especially on opposite site

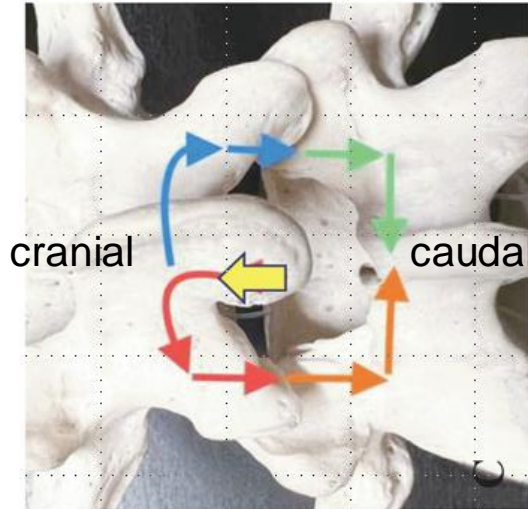
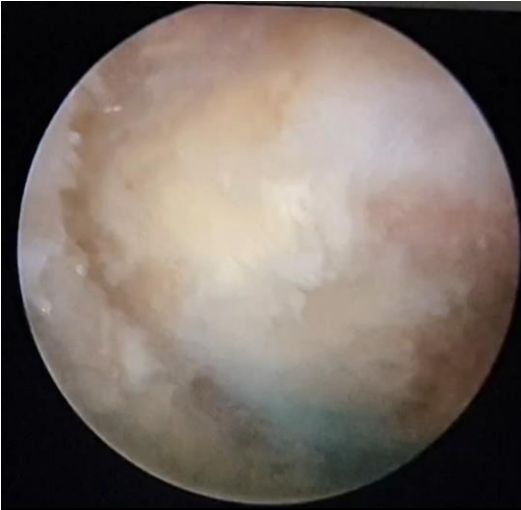
- **Demerits**

- Nerve compression during separation of Lig, Flavum???



Performing the Butterfly Technique

- Anatomy of the yellow ligament

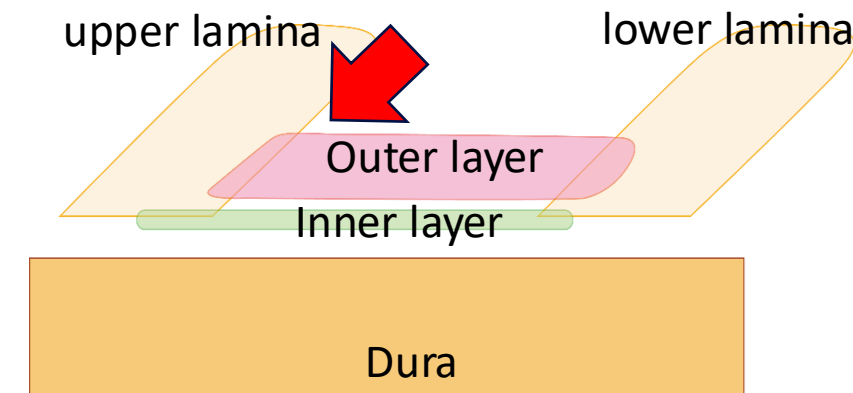
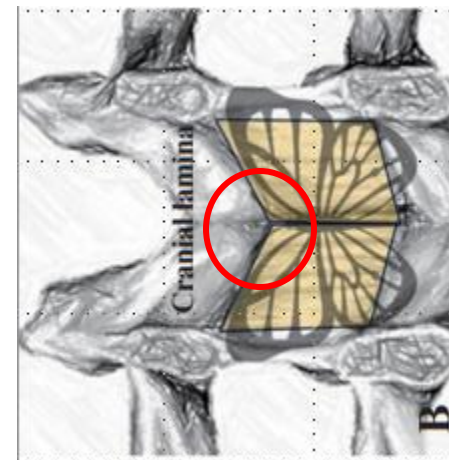
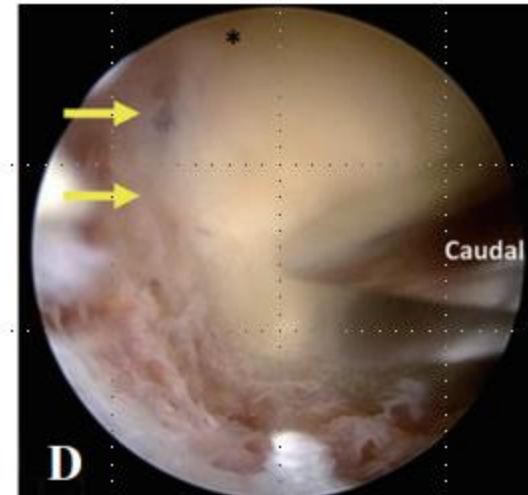
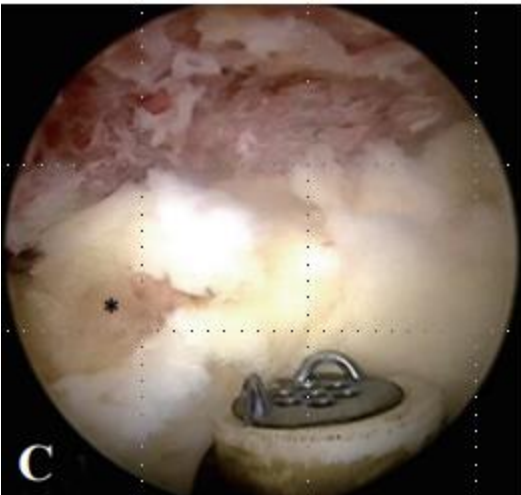


- Exposing the "head of butterfly"

After start drilling from spino-laminar junction, we widen the junction to expose the "head of the butterfly".

It is located at midline, so as you can see(C), head can be detached from proximal lamina.

When you drill through the lateral part of lamina, you can finish the ipsilateral upper drilling to expose the wing of the butterfly.



Performing the Butterfly Technique

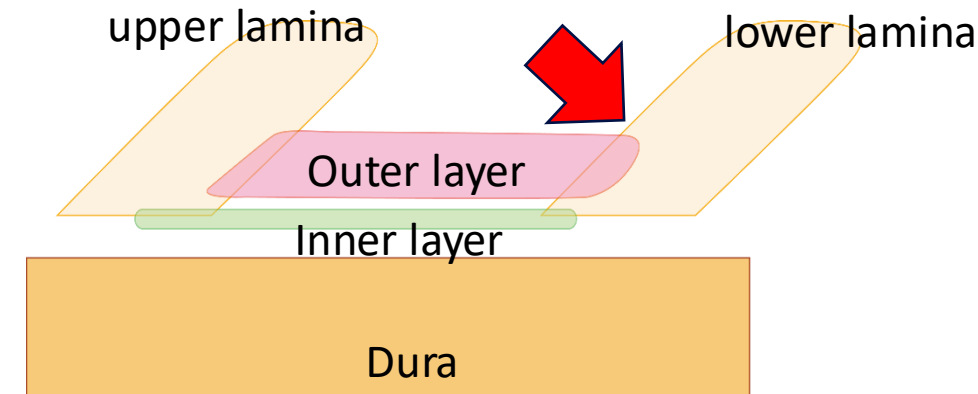
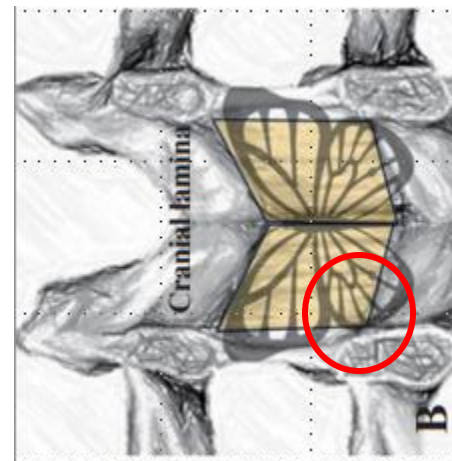
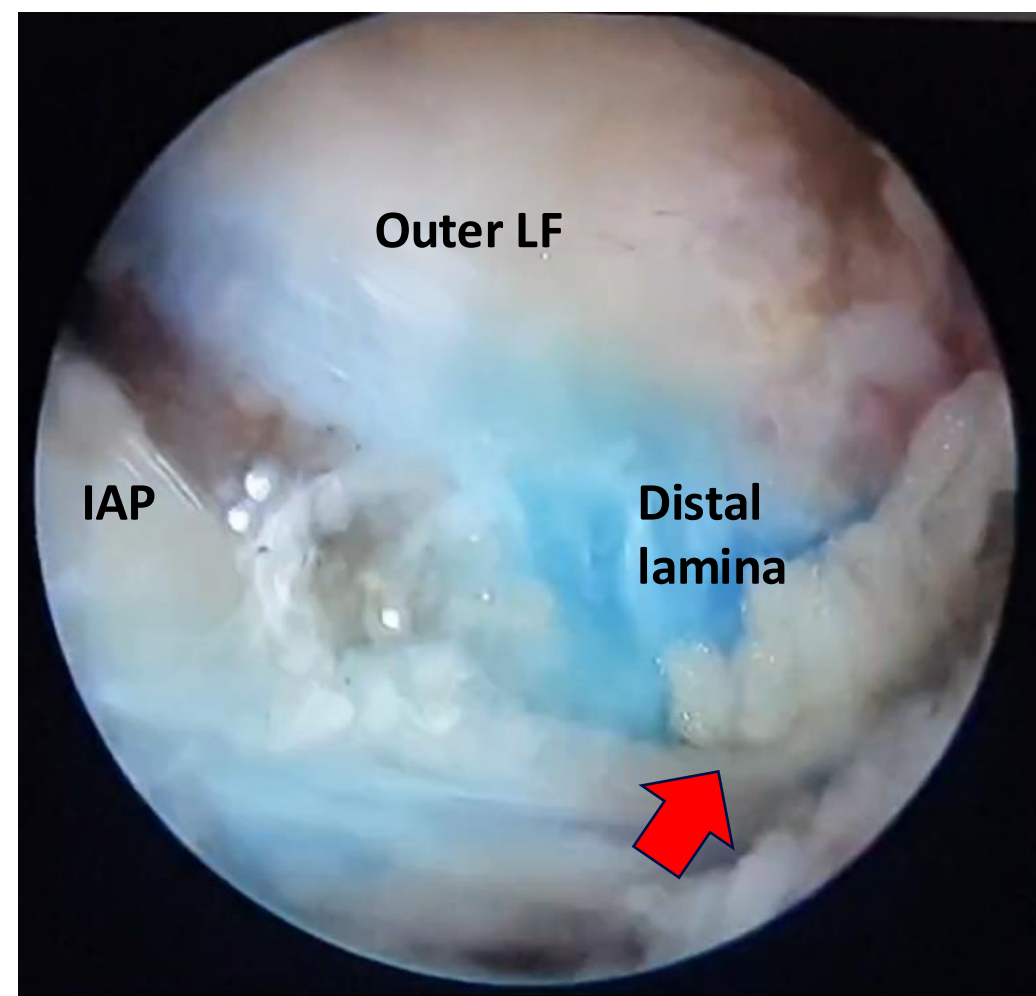
- Anatomy of the yellow ligament

- Visualization of Outer LF

We can see the tip of IAP, outer Ligamentum flavum and distal lamina at this point.

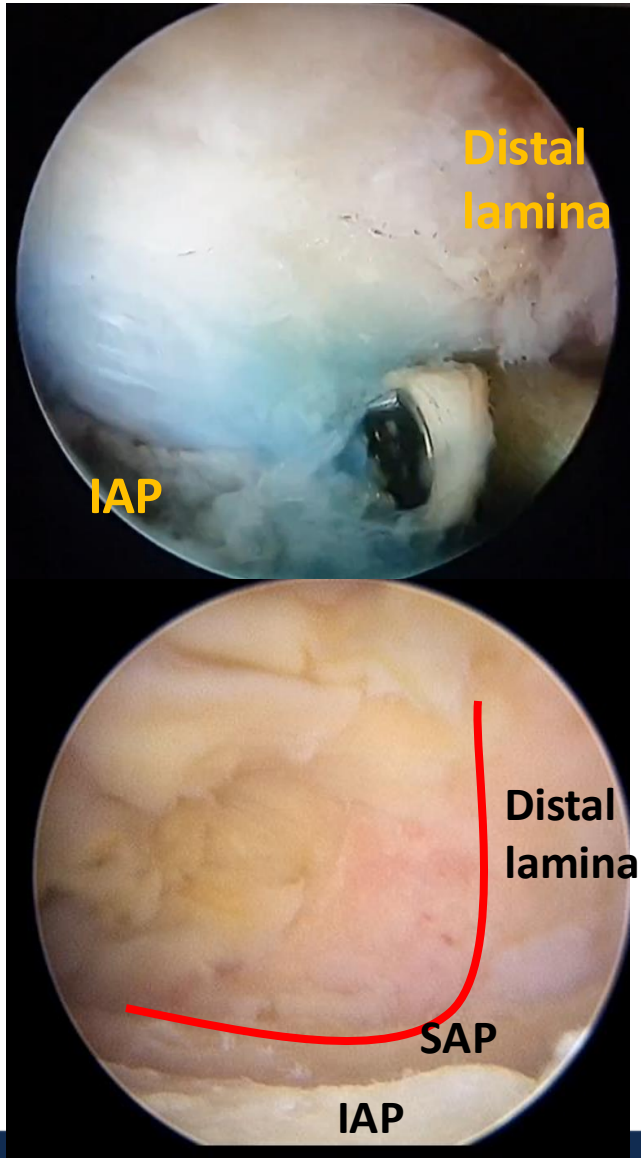
Outer ligamentum flavum is attached to distal lamina and medial wall of IAP.

We may remove outer LF connecting IAP and distal lamina



Performing the Butterfly Technique

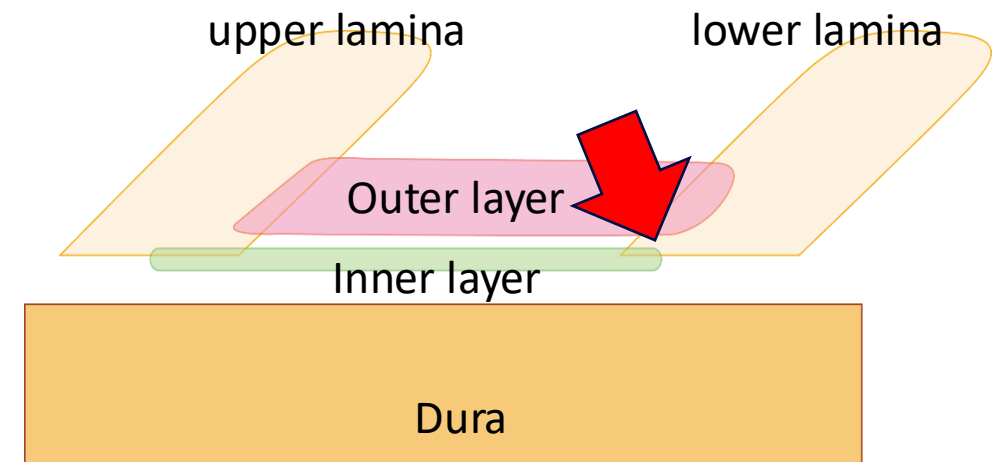
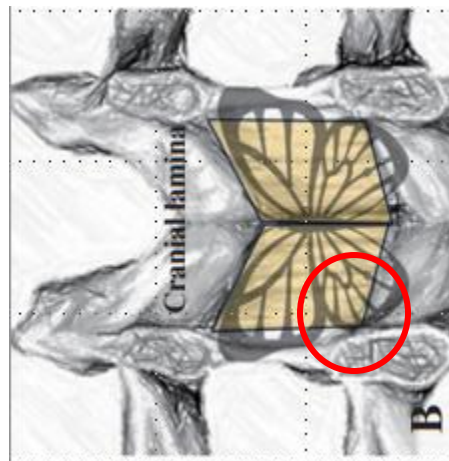
- Anatomy of the yellow ligament



- Visualizaion of the “L-line”

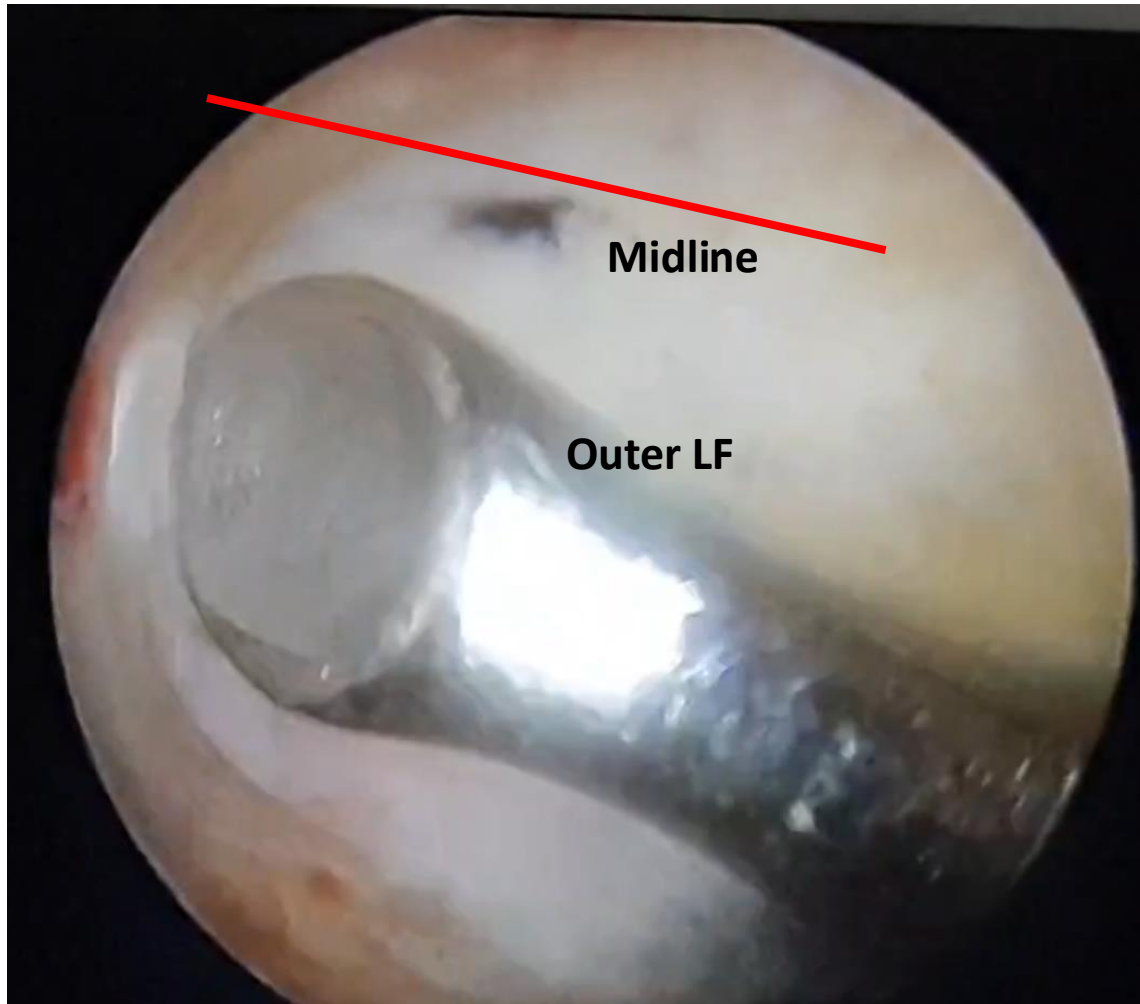
Since the outer layer is attached to surface of distal lamina, and inner layer is attached to inner part of distal lamina and medial border of SAP, it is important to remove part of distal lamina to visualize the inner layer of LF and medial wall of SAP.

As you can see in this figure, when you remove part of outer layer of LF, you can see the SAP below the IAP, and round shape of bony margin. We call it “L line.” You can see the inner flavum attached to the medial wall of SAP



Performing the Butterfly Technique

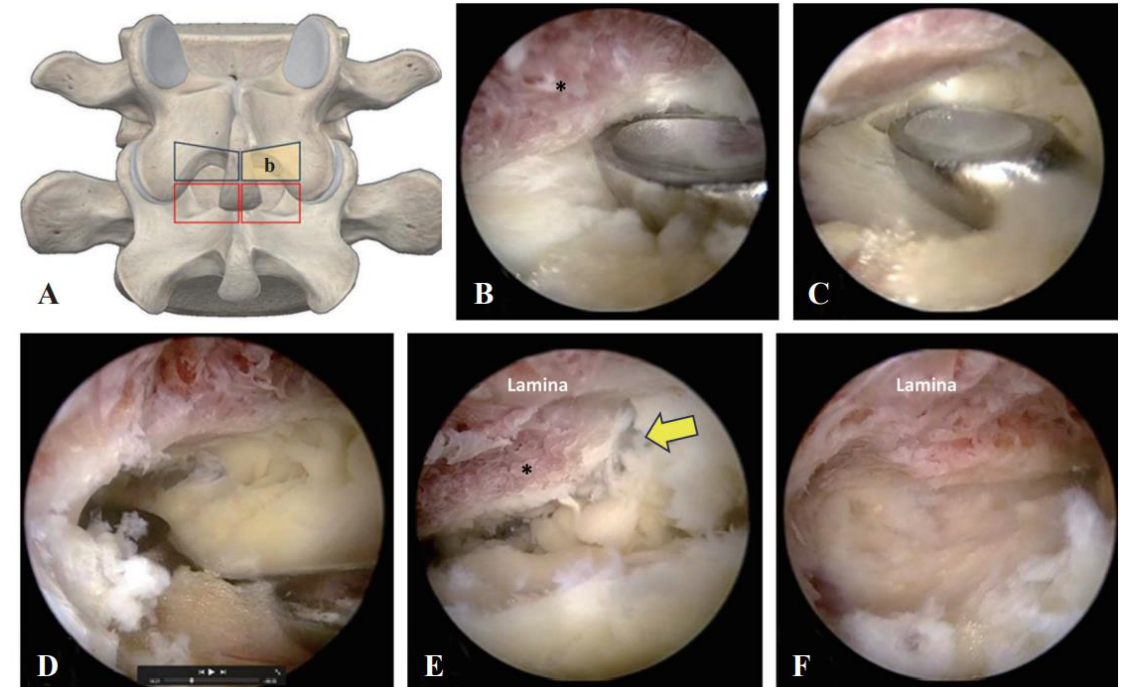
- Anatomy of the yellow ligament



- **Exposing the contralateral tip of butterfly wing**

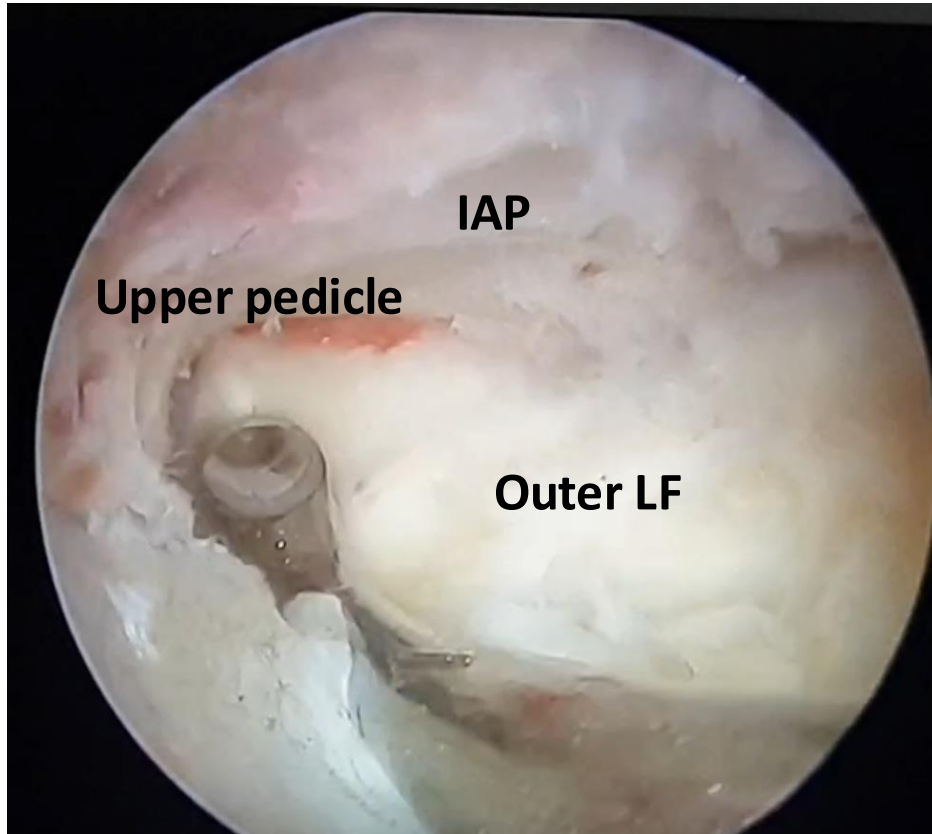
After finishing exposing ipsilateral “butterfly wing,” we can now expose contralateral butterfly wing.

We can separate outer LF from inner cortical bone of contralateral lamina, and start drilling lamina bone.



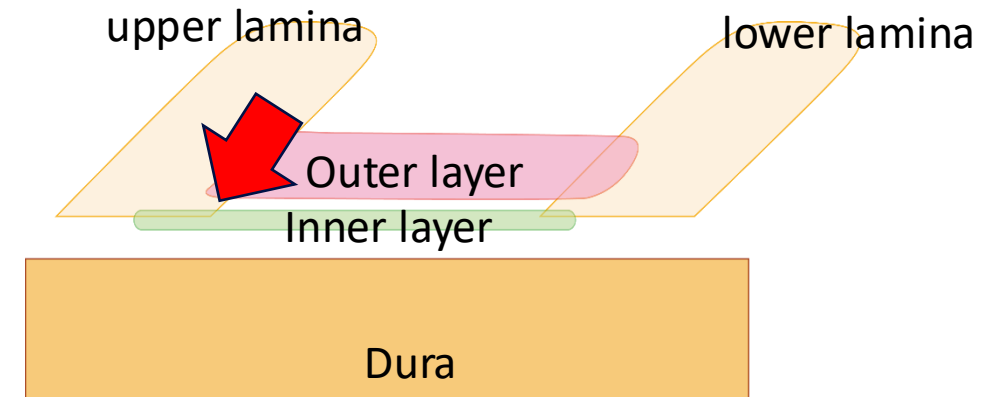
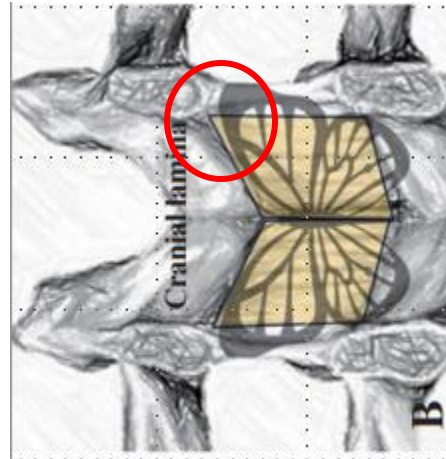
Performing the Butterfly Technique

- Anatomy of the yellow ligament



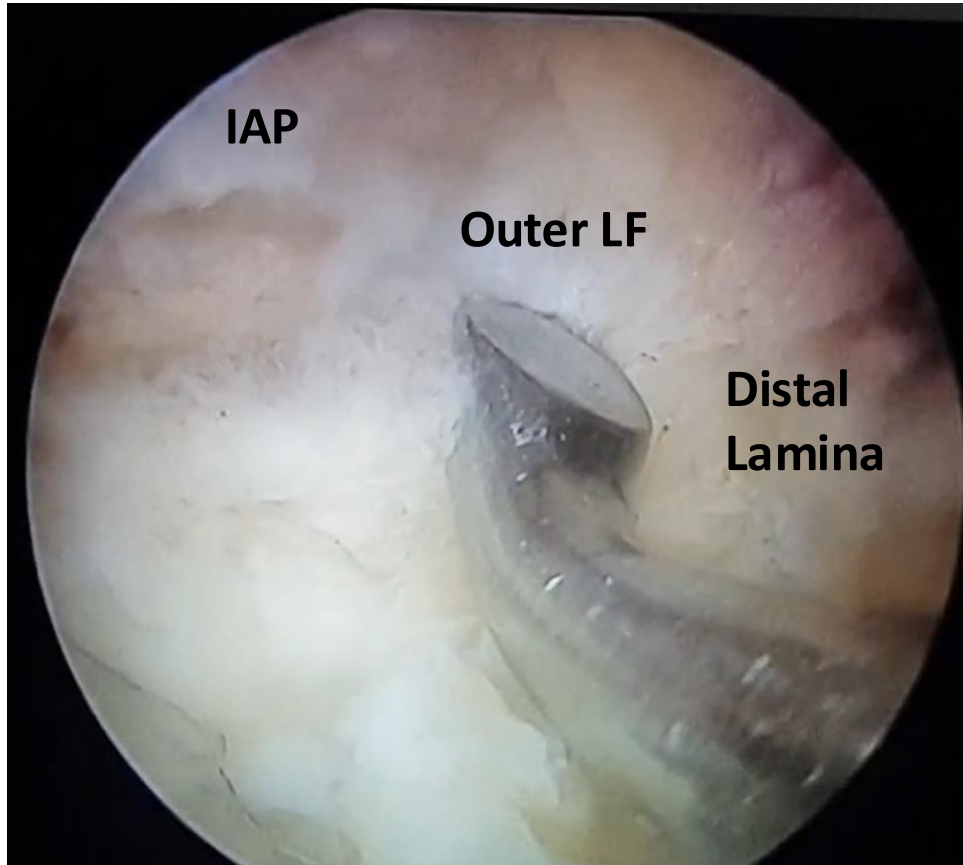
- Exposing the contralateral tip of butterfly wing

After drilling contralateral side, you can expose the contralateral tip of butterfly wing. It can be detached from upper pedicle.



Performing the Butterfly Technique

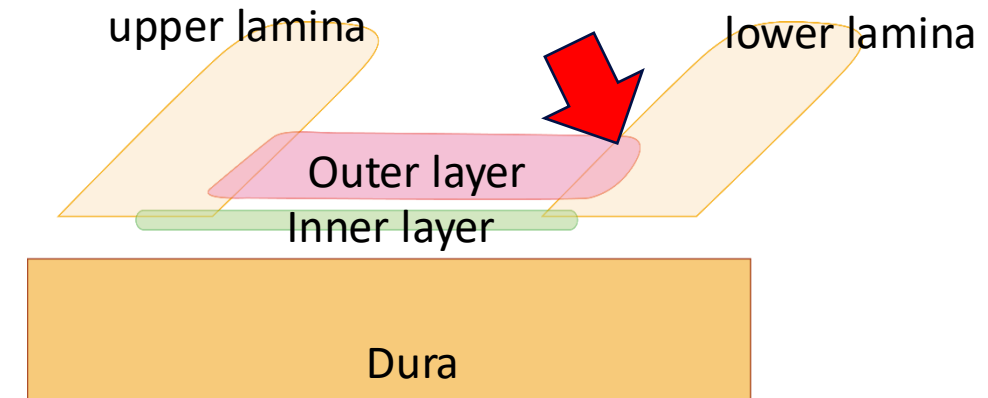
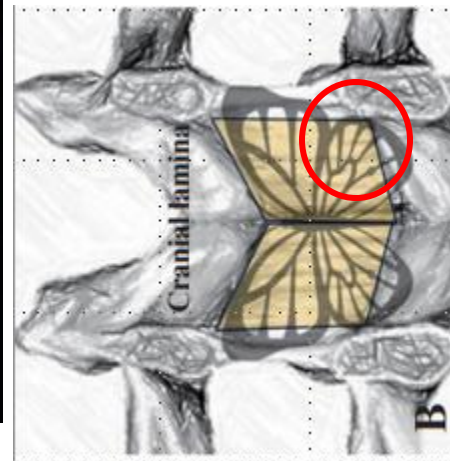
- Anatomy of the yellow ligament



• Visualization of Outer LF

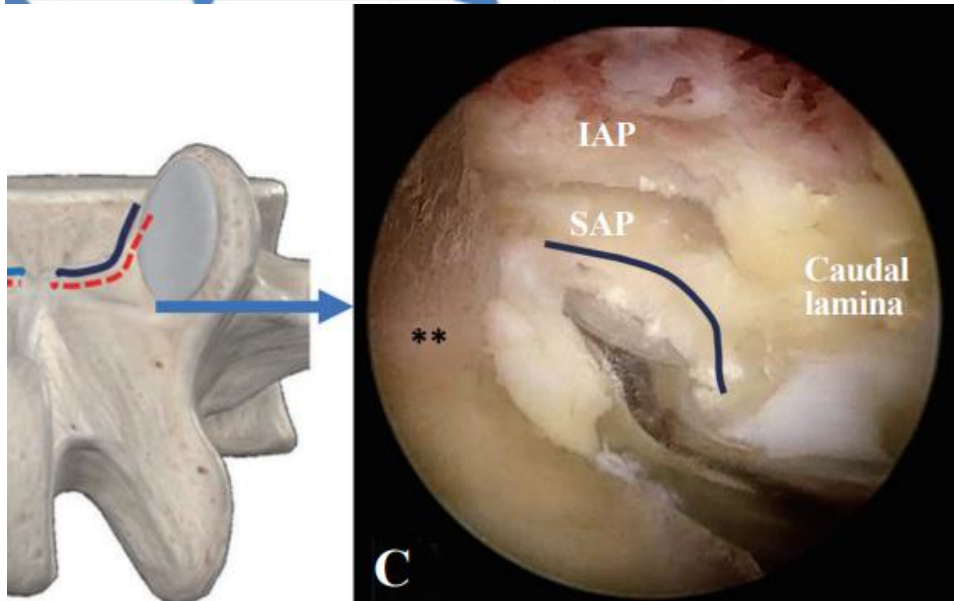
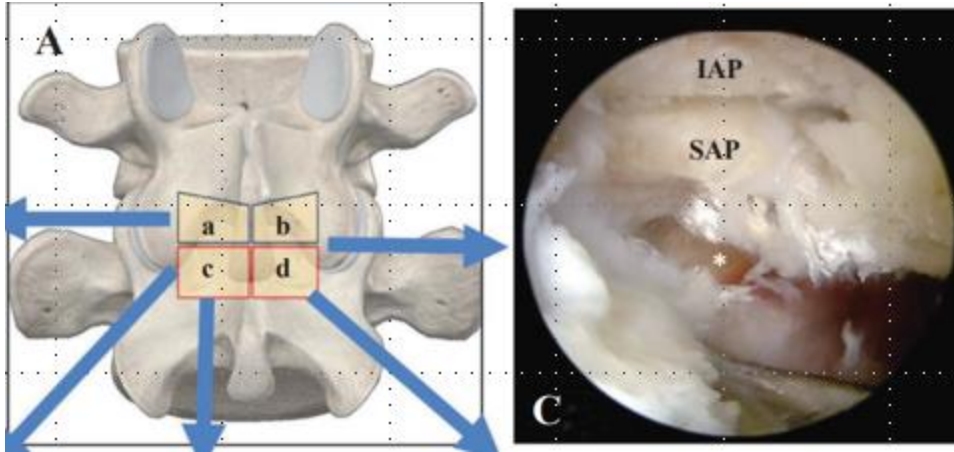
In the contralateral distal lamina, you can see IAP, outer LF and distal lamina as in the picture.

Outer LF must be removed from the distal lamina to visualize SAP



Performing the Butterfly Technique

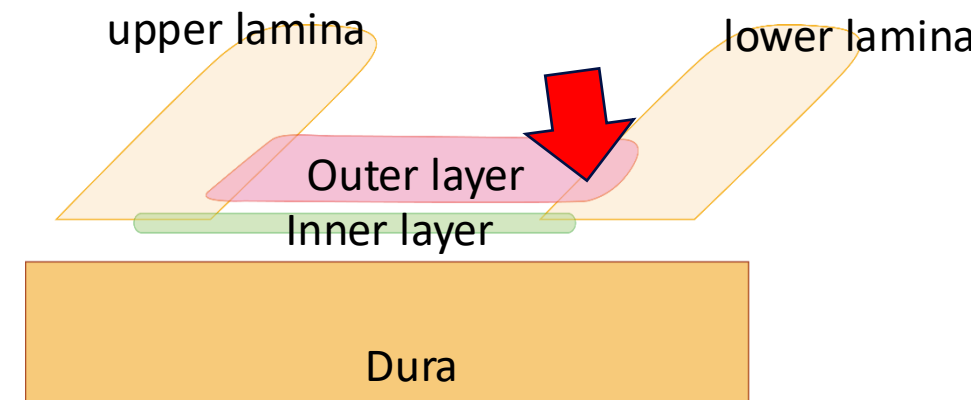
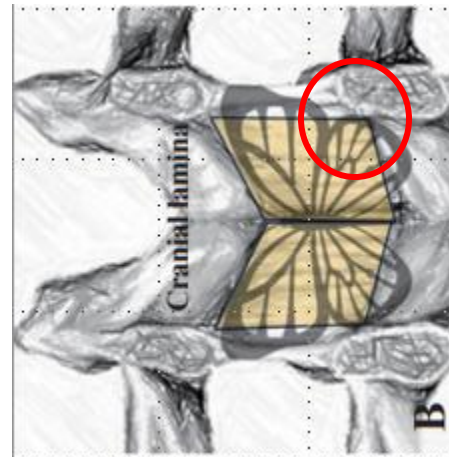
- Anatomy of the yellow ligament



- Visualization of “J-line”

You can see IAP, SAP, and distal lamina.

Compared to “L line”, part of IAP drilling, and removal of outer LF can visualize the “J line.” Inner LF is attached to SAP medial wall.



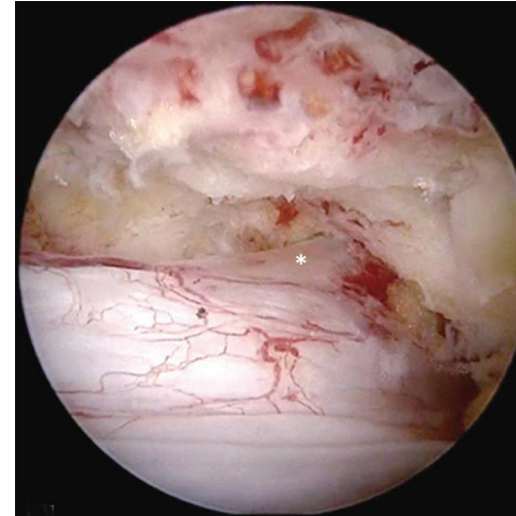
Advantages of En Bloc LF Removal

- Reduced Risk of Dural Tear

> J Orthop Surg Res. 2024 Dec 3;19(1):815. doi: 10.1186/s13018-024-05317-3.

En bloc resection of the ligamentum flavum for bilateral decompression in unilateral biportal endoscopic transforaminal lumbar interbody fusion: a 2-year follow-up study

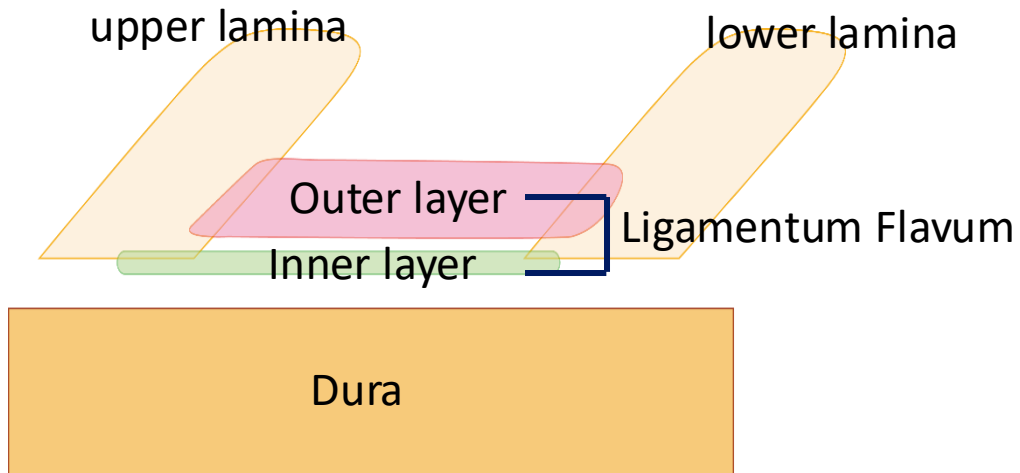
Chao Li ^{# 1}, Beiyu Xu ^{# 1}, Yao Zhao ¹, Longtao Qi ¹, Lei Yue ¹, Ranlyu Zhu ¹, Chunde Li ¹, Zhengrong Yu ²



- Epidural space opens later, decreasing early-stage dural tear risk
- Early-stage dural tear may require conversion to open microdiscectomy

Advantages of En Bloc LF Removal

- Protective Role During Drilling



- LF acts as a barrier protecting the dura and nerves
- Allows for faster and safer drilling → Reducing surgical time

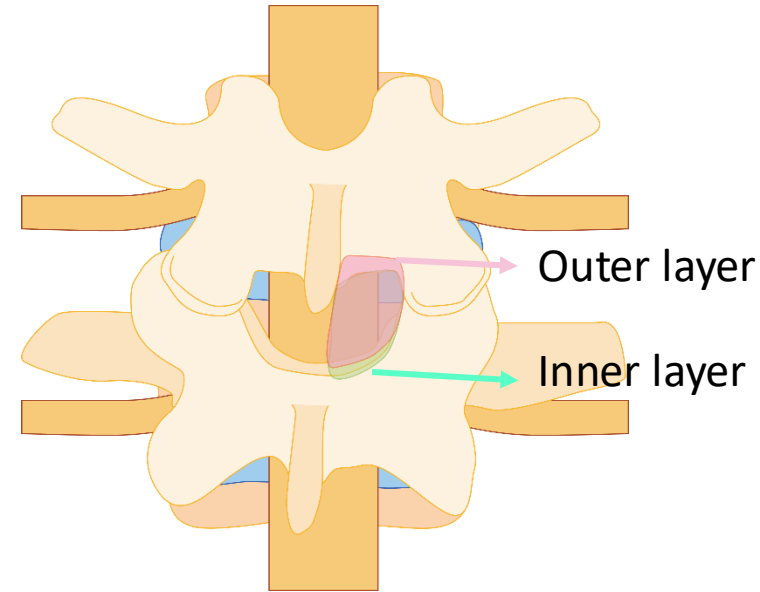
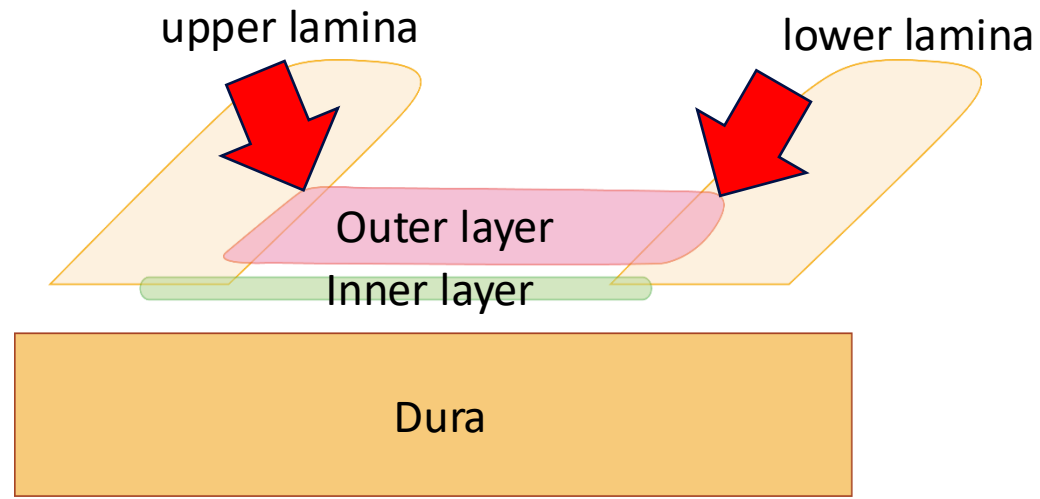
Advantages of En Bloc LF Removal

- En Bloc Removal vs. piecemeal Removal

	En block removal	Piecemeal removal
Definition	A method of removing the LF in one or two large pieces	A method of removing the LF by breaking it into multiple smaller pieces
Epidural Space Opening	Last stage	Early stage
IICP Risk	Lower	Higher
Dural Tear Risk	Reduced	Higher
Bleeding Control	Predictable	Less control
Drilling Efficiency	Faster, safer	Slower, more delicate

Performing the Butterfly Technique

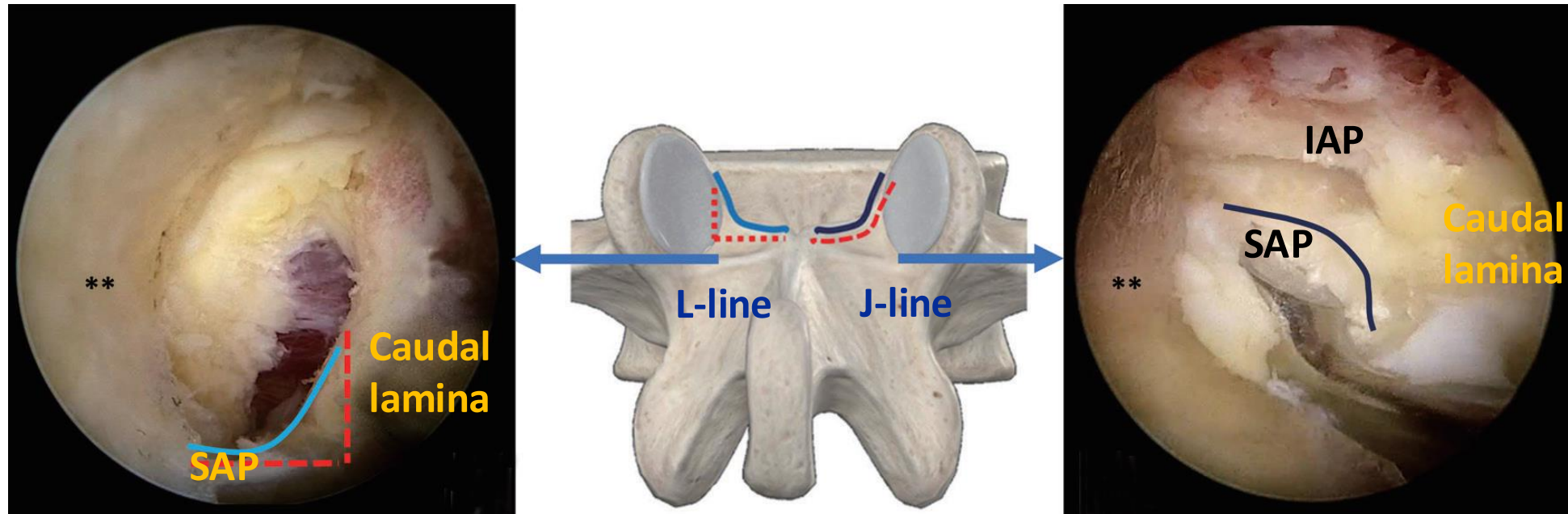
- Anatomical Understanding of LF



- LF consists of outer layer and inner layer
- Outer layer must be detached to expose J-line & L-line
- Inner layer separation allows for en bloc LF removal

Performing the Butterfly Technique

- J-Line and L-Line Exposure

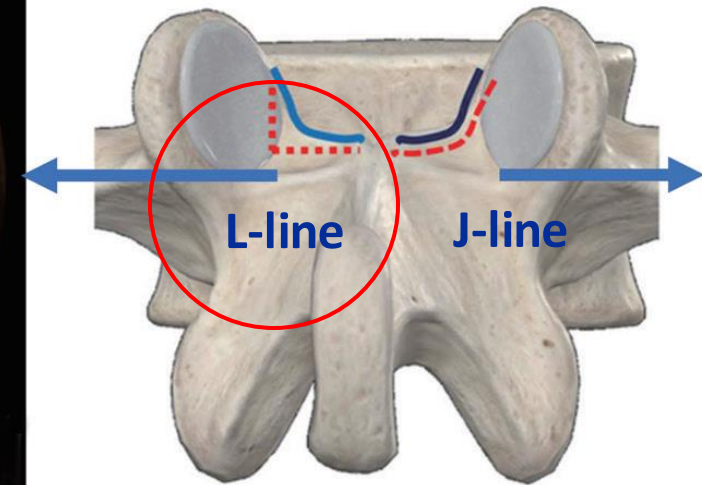
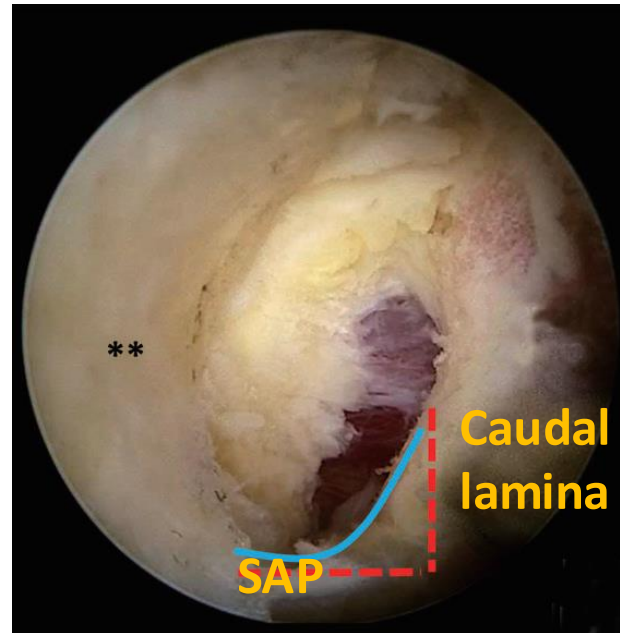


- To detach the outer layer is necessary to expose the J-line & L-line
- Inner layer is preserved while performing separation

Performing the Butterfly Technique

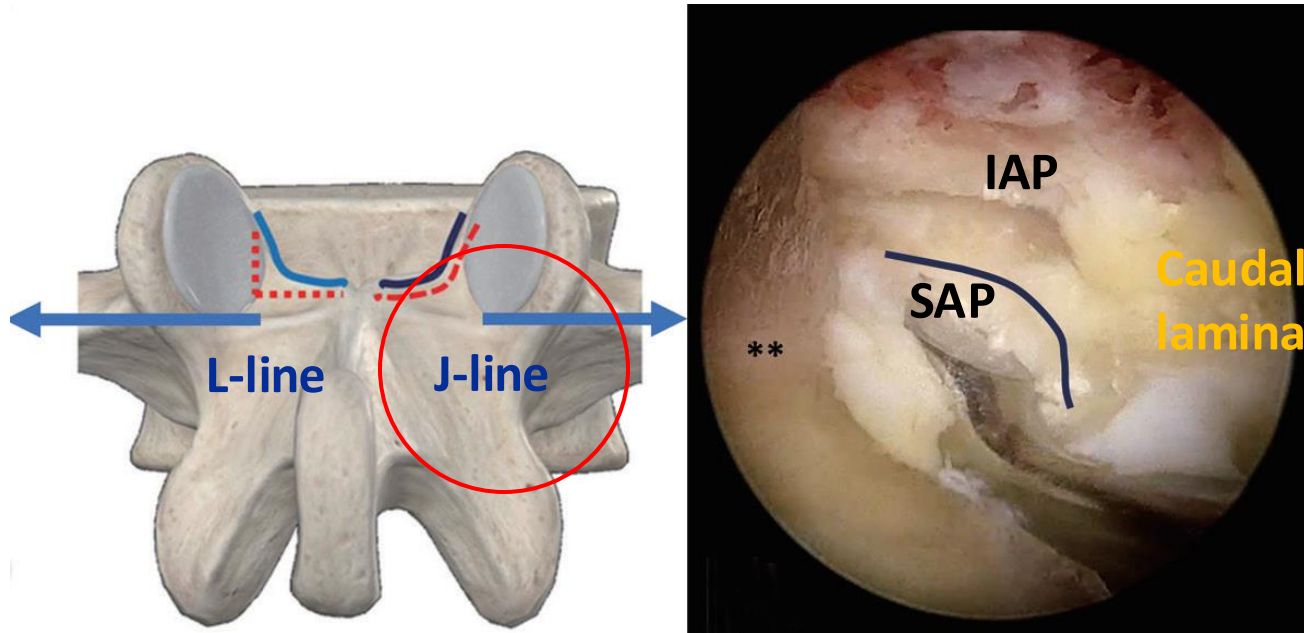
- J-Line and L-Line Exposure

- L Line: The L line is formed by the upper margin of the distal lamina and the inner layer of the SAP on the left side.



Performing the Butterfly Technique

- J-Line and L-Line Exposure



- J Line: The J line is formed by the upper margin of the distal lamina and the inner margin of the SAP on the right side.

Performing the Butterfly Technique

- Anatomy of the yellow ligament



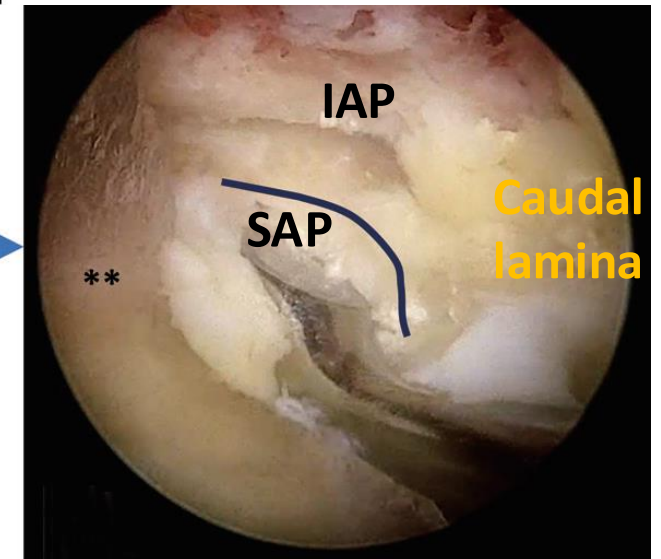
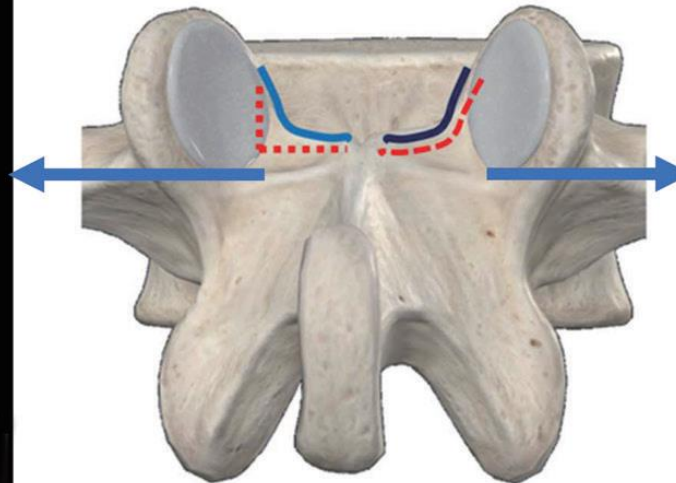
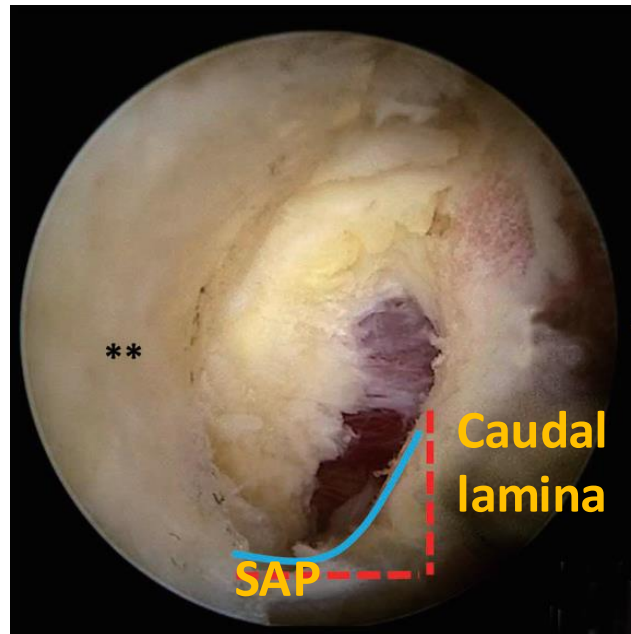
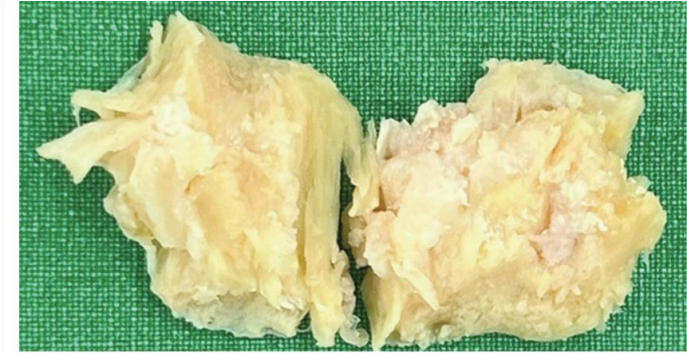
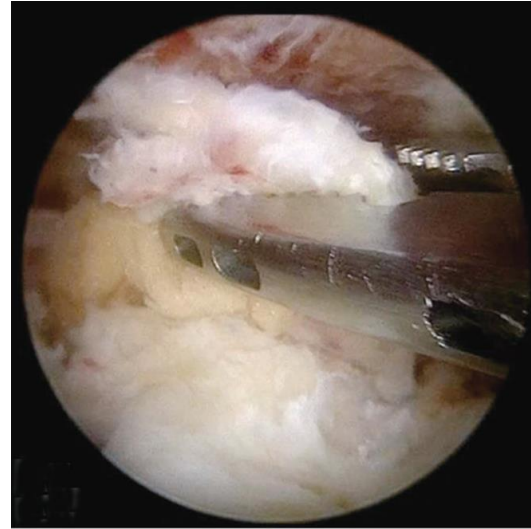
- **Butterfly Technique**

After Exposing the “L-line” and the “J-line”, Deep layer of LF can be removed as a whole piece. Using Kerrison punch and curette, It can be separated from the lamina bone, and removed.

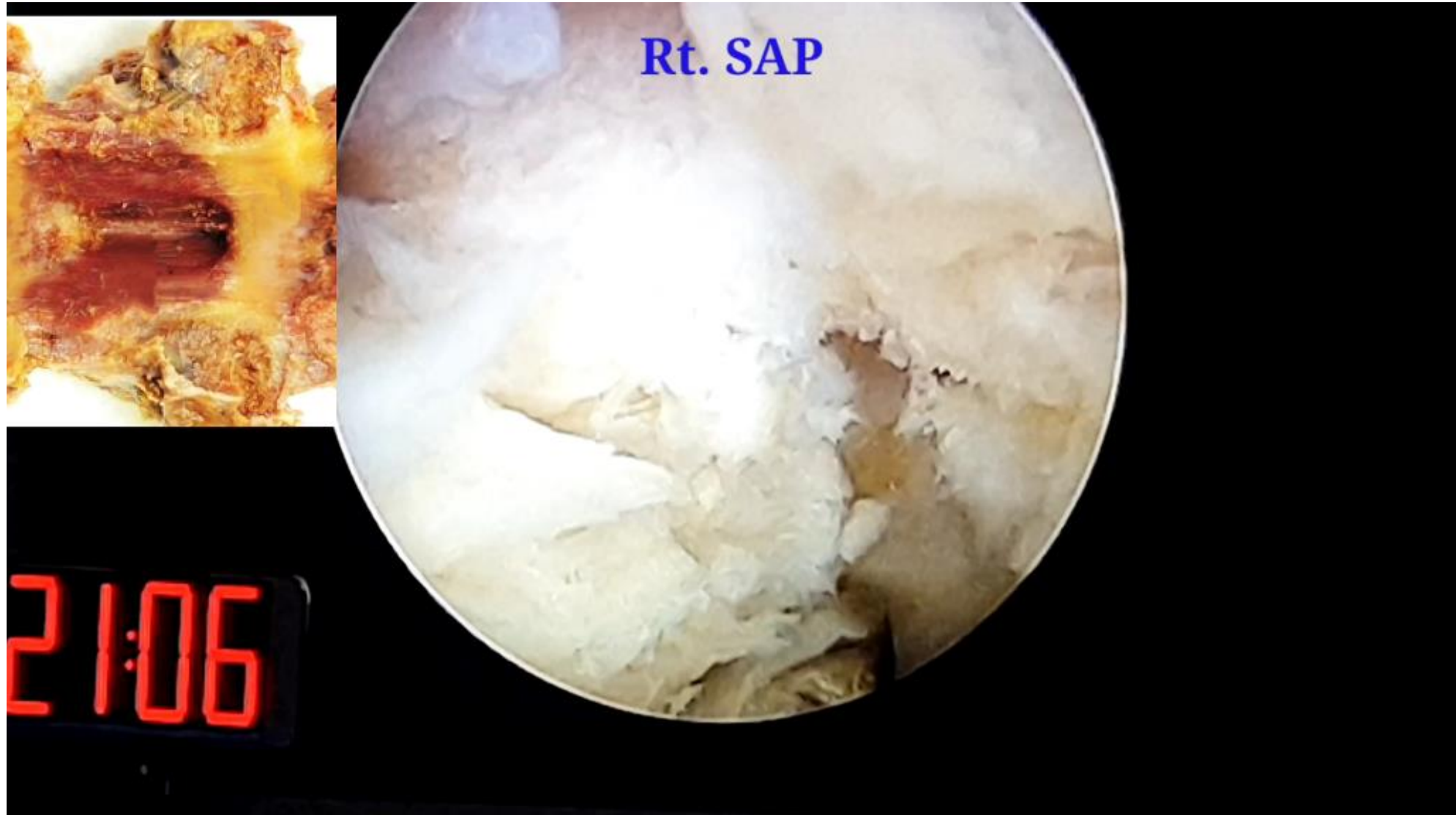
You may see the whole piece of removal in this video, and see the whole piece of the “butterfly”. This is why it is called the “butterfly technique”

Performing the Butterfly Technique

- Drilling extent and precision
- Cranial Y shape separation of LF
- Expose of both lateral recess and SAP



Performing the Butterfly Technique



Performing the Butterfly Technique

- Staging your operation is very important

1) Drilling stage:

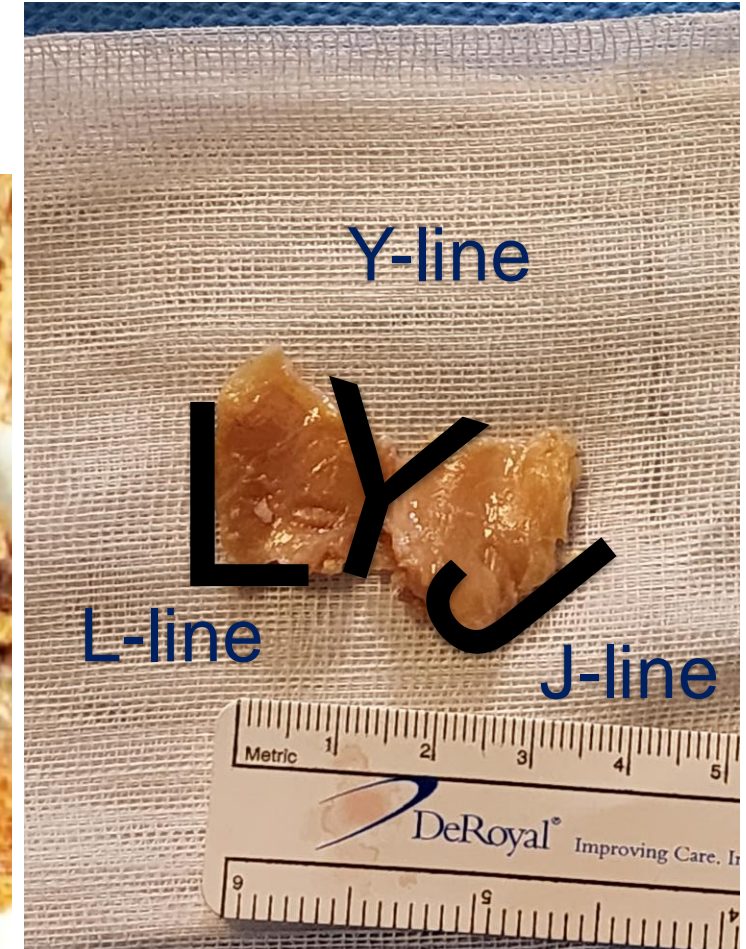
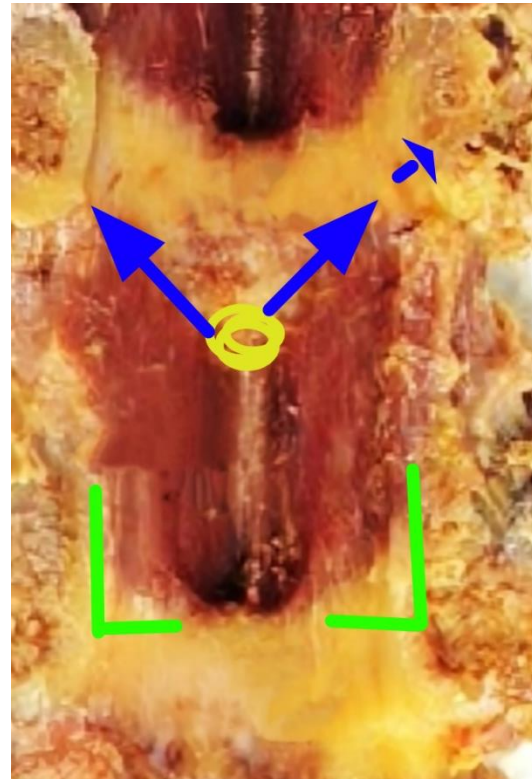
- Cranial Y shape separation of LF
- Expose of both lateral recess and SAP

2) Detachment of Flavum

- Attachments are weak on the “L and J line”
- gentle compression and pulling will detach LF

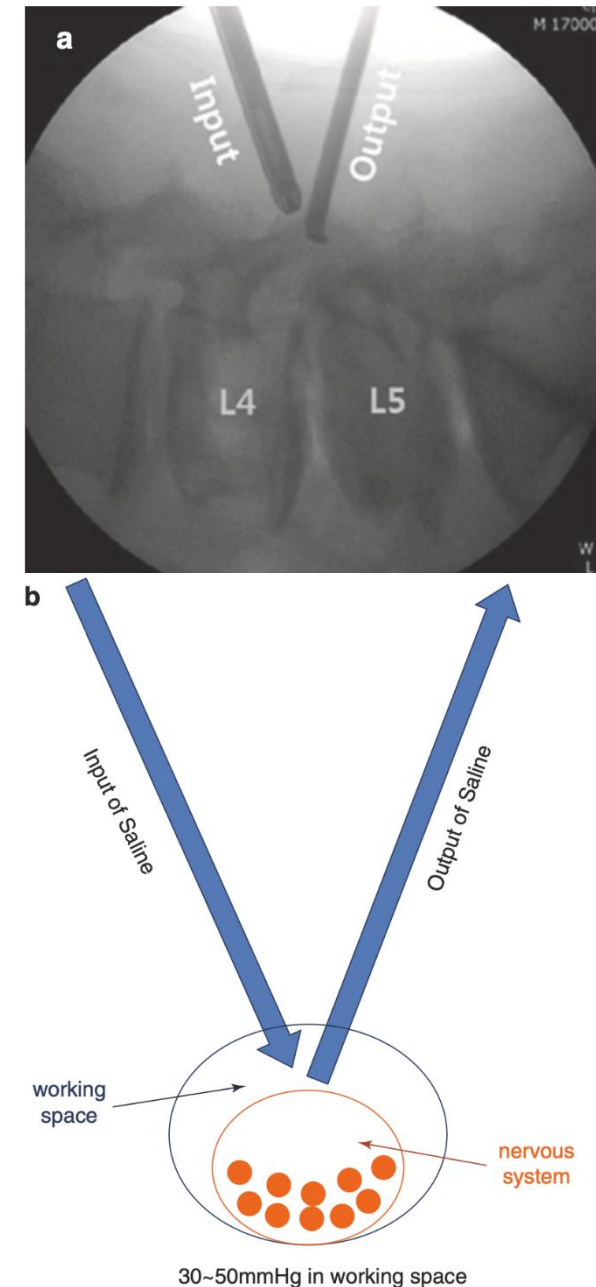
3) Separation of LF from Dura

4) Extraction of LF Enbloc



Basic and concepts of UBE

- **UBE is fluid-medium surgery, not air-based**
 - similar to joint arthroscopic surgery
 - 2 surgical portals are needed on the same side
 - Factitious space in UBE does not have an envelope and is very close to the epidural space without any separating structure
- **MUST maintain outflow of the irrigating saline to prevent complications due to high hydrostatic pressure**



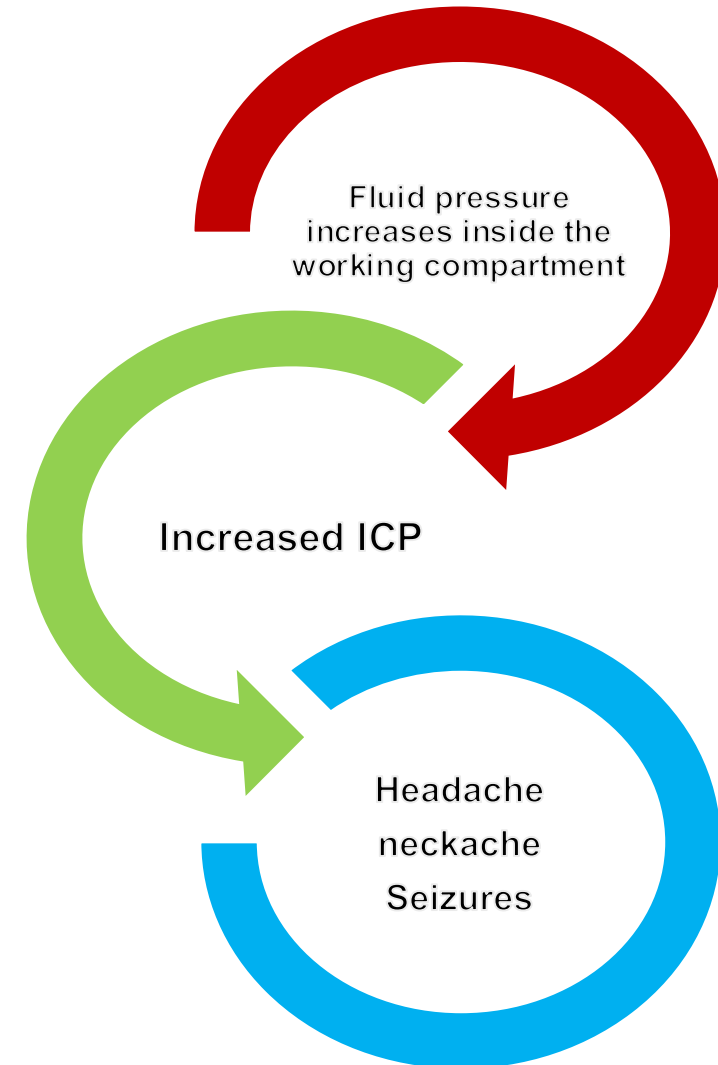
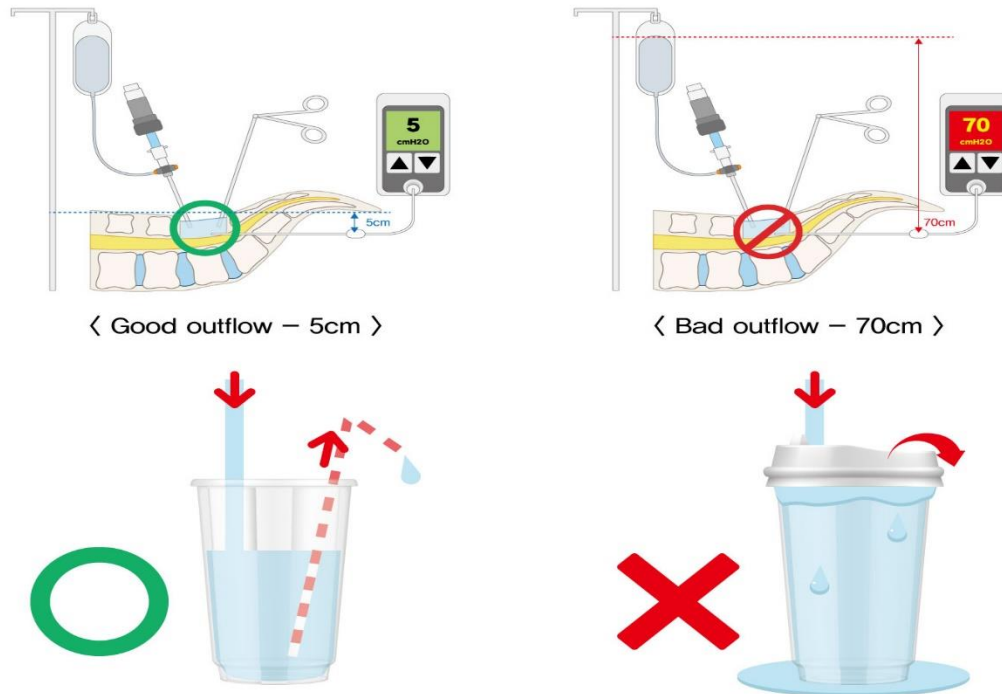
Pressure Management in UBE Surgery

- Water pressure management

- Risk of increase intra cranial pressure**

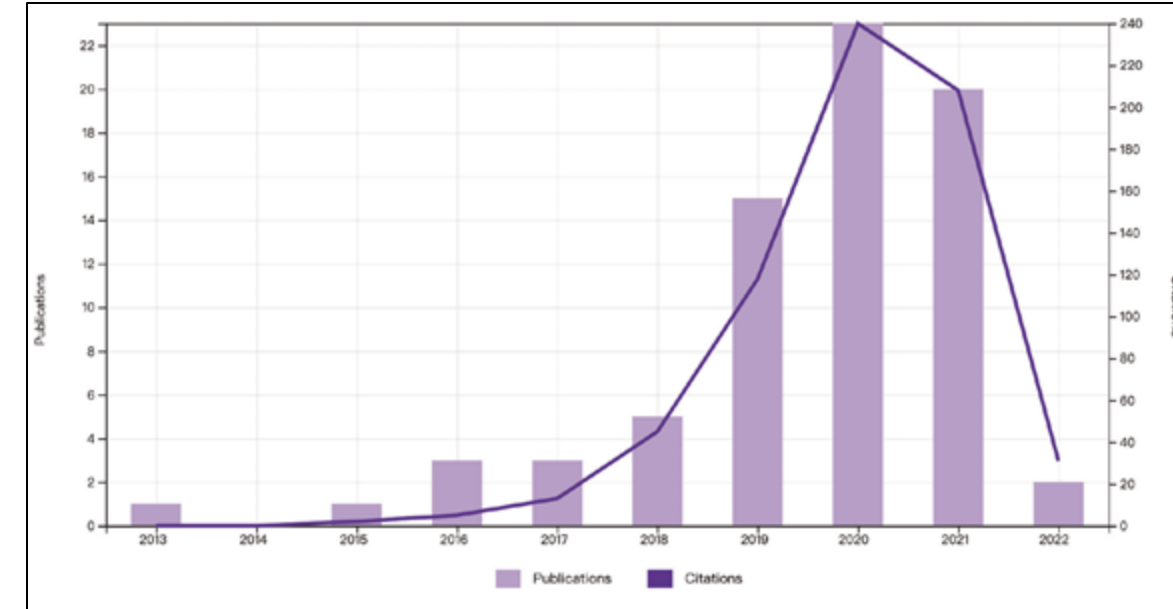
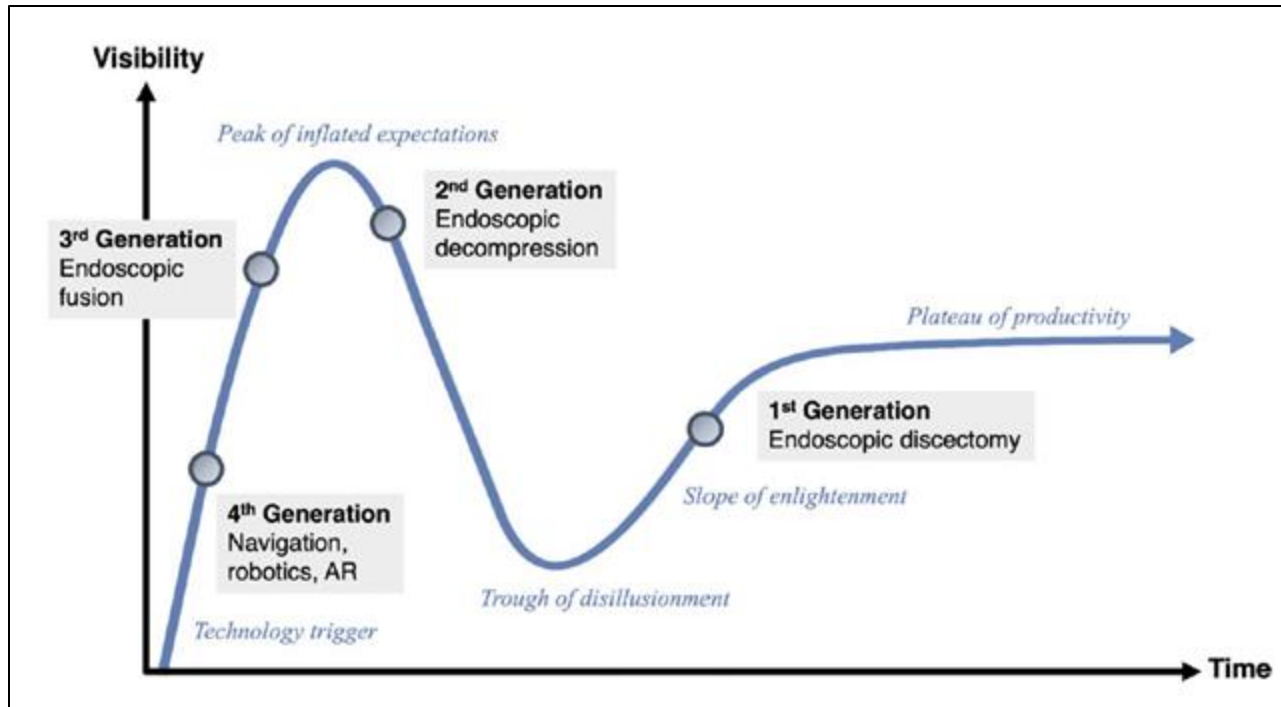
- Spinal canal is connected to cranium which encases the brain thus restricting the fluid management.
 - Normal ICP is 5-15mmhg(7-21 cm H₂O)

- **Need to maintain outflow to prevent IICP**



Popularity of Minimally Invasive Endoscopic Spine Surgery

- Continuous development in past few years
- In Gartners hype cycle, endoscopic decompression has passed the peak of inflated expectation
- Endoscopic fusion on the rise



Minimally invasive endoscopy in spine surgery: where are we now?

Khanathip Jitpakdee^{1,2} · Yanting Liu² · Dong Hwa Heo³ · Vit Kotheraanurak^{4,5} · Siravich Suvithayasiri^{2,6} · Jin-sung Kim²

Mapping knowledge structure and themes trends in unilateral biportal endoscopic spine surgery: A bibliometric analysis

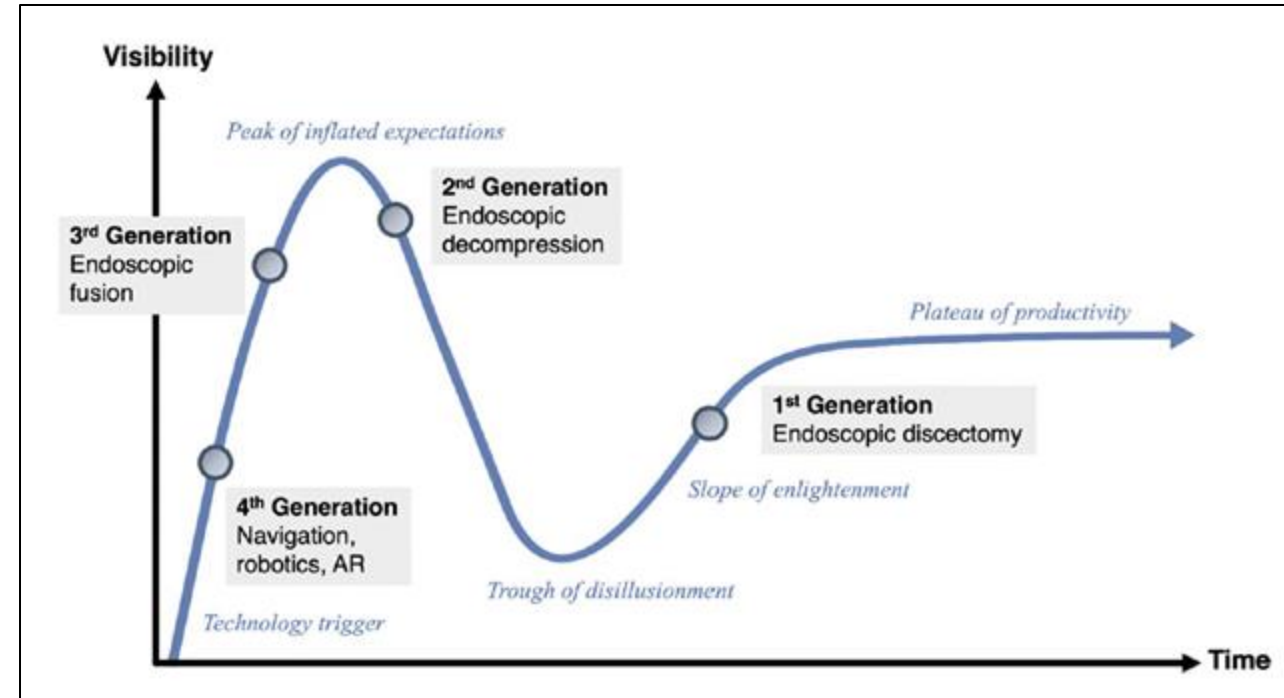
Ming-Tao Zhu^{1†}, Kunrong Li^{1†}, Bao-Shan Hu^{2†}, Chien-Min Chen^{3,4,5} and Guang-Xun Lin^{2,6*}

Endoscopic fusion yet to reach the peak

- Lift-up technique

1. Constant development

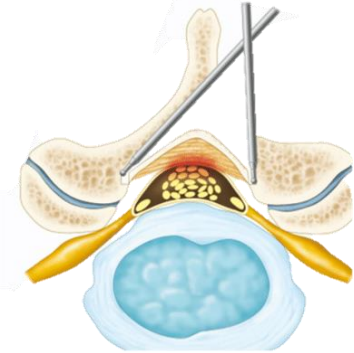
- Customized instruments
- Expandable cages
- Biologics
- Nerve protecting retractors
- Surgical technique



2. Endoscopic fusion is yet to reach the peak

3. Before reaching maturity of technique, cage related complications and pseudoarthrosis will start getting reported

Thoracic and Cervical Techniques



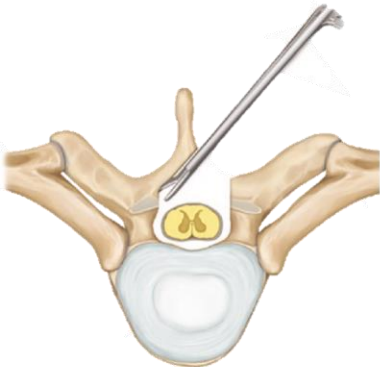
- **Cervical spine**(Posterior approach)

- Disc herniation, foraminal stenosis, myelopathy



- **Thoracic spine**(Posterolateral)

- Disc herniation, foraminal stenosis, myelopathy

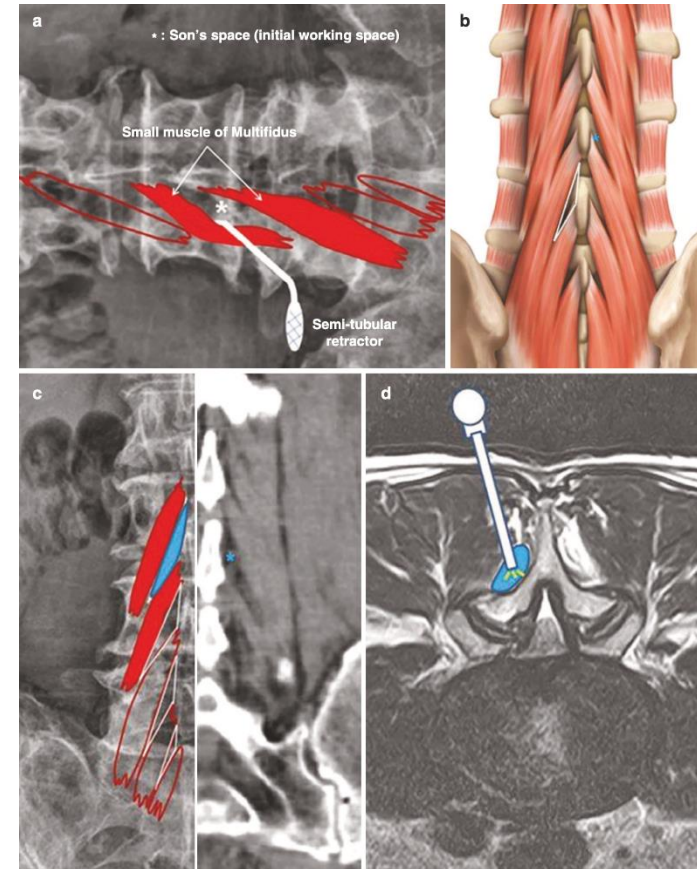


- **Lumbar spine**(Transforaminal, interlaminar, paraspinal or contralateral approach)

- Disc herniation, Central & Foraminal stenosis, Interbody fusion, Tumor removal

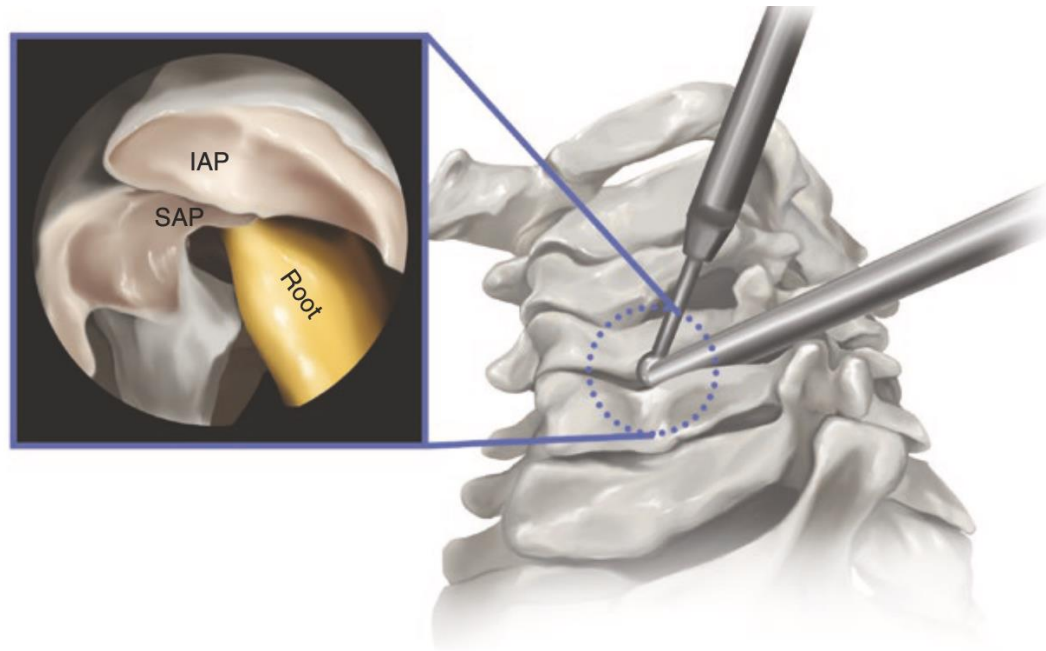
Cervical Techniques

- Endoscopic surgery require working space of Cervical spine
- **Posterior approach**
 - Create atraumatic potential space between multifidus
 - Use water as medium to maintain working space
- **Kambin's triangle**
 - Supply corridor for transforaminal lesion

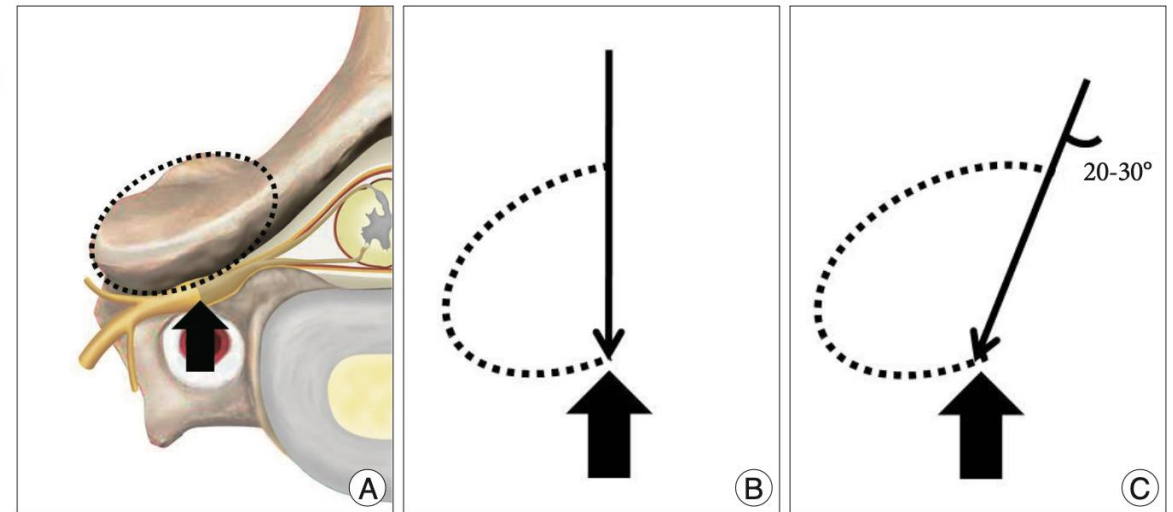


Cervical Techniques

- Approach selection - Inclinary foraminotomy (contralateral)
- Suitable for unilateral foraminal stenosis



Contralateral standing with lesion

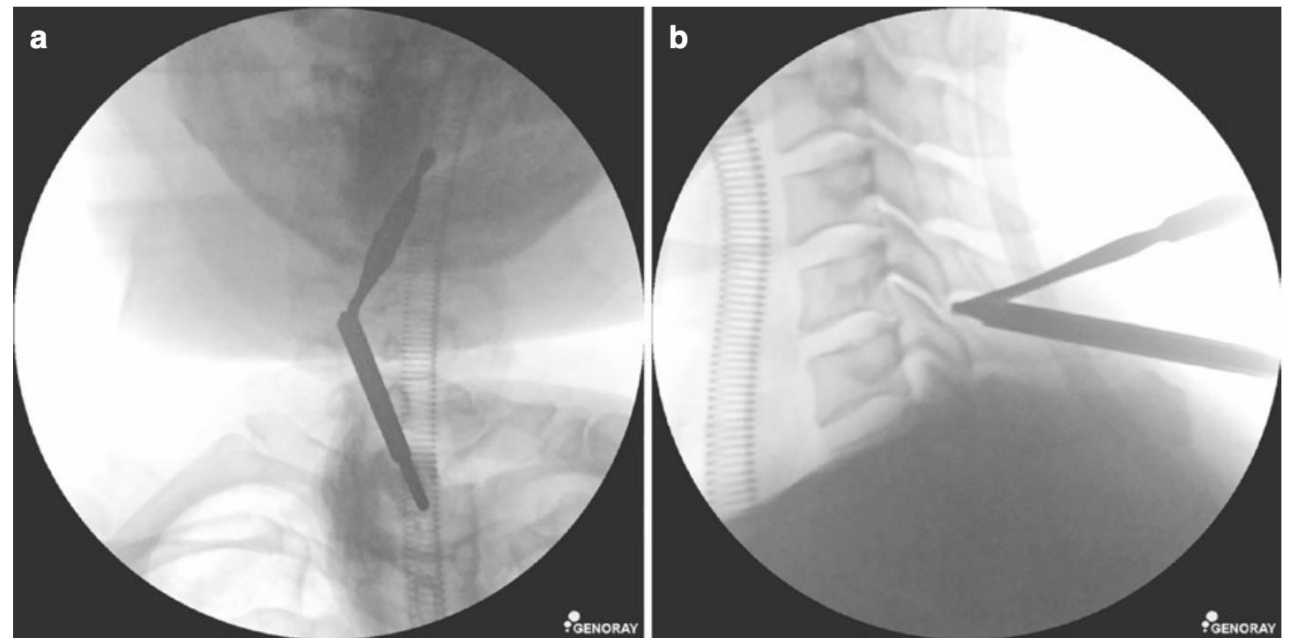
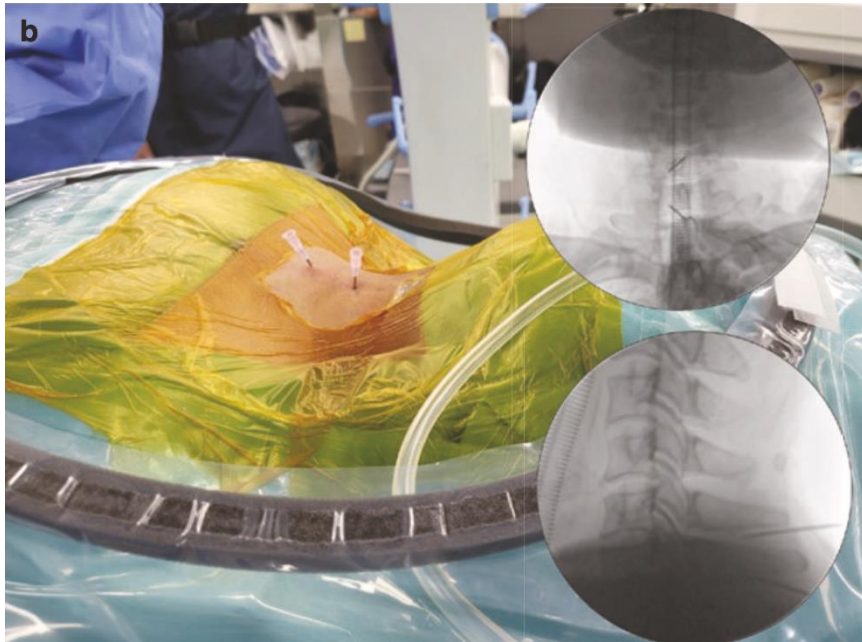


Less bone drilling of facet joint

Cervical Techniques

- Application of UBE in C-spine surgery

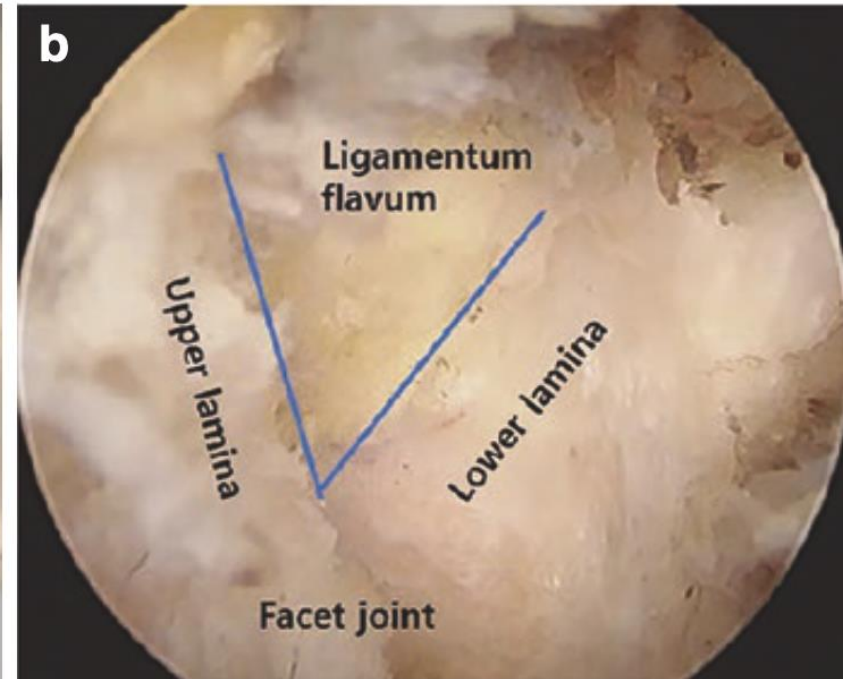
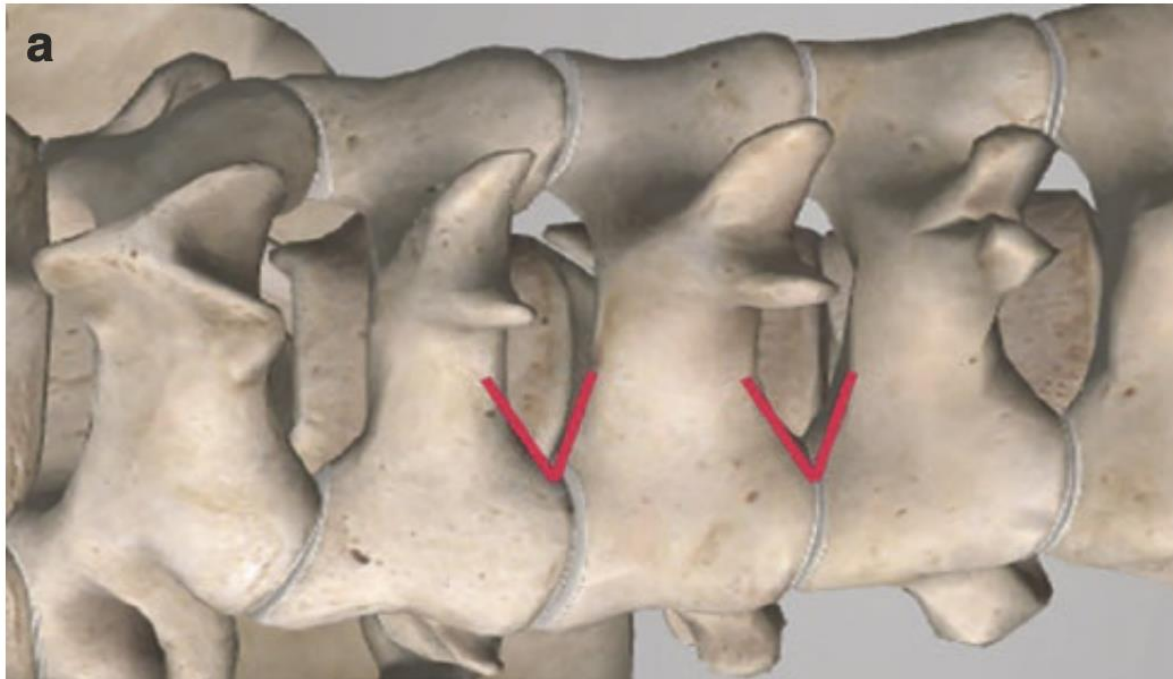
1. Identify level by apply needle & inject methylene blue
2. After incisions were made, perform triangulation over V-point

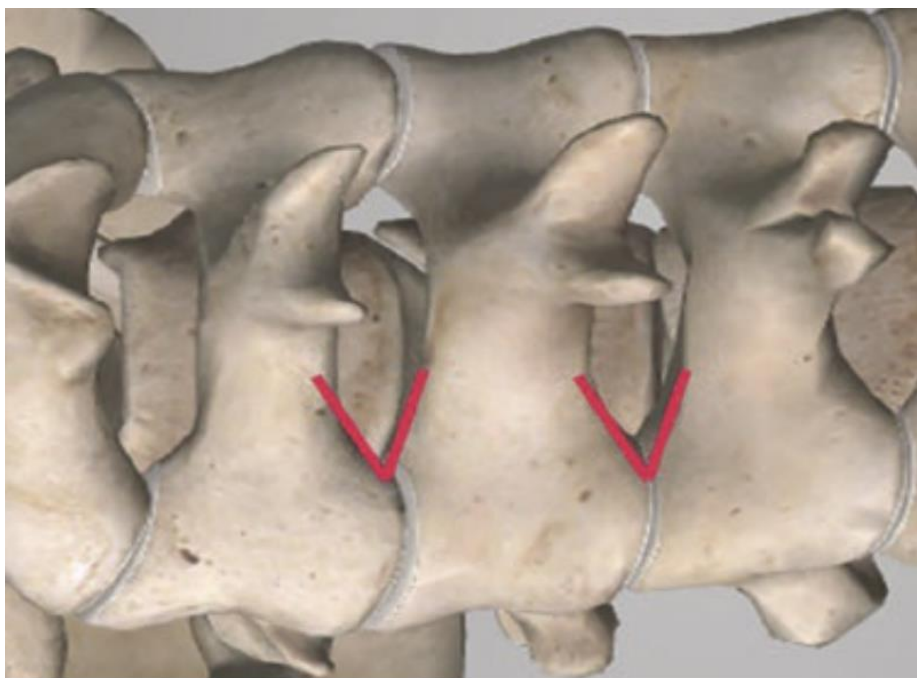


Cervical Techniques

- Application of UBE in C-spine surgery

-Bone work start from finding the V-point

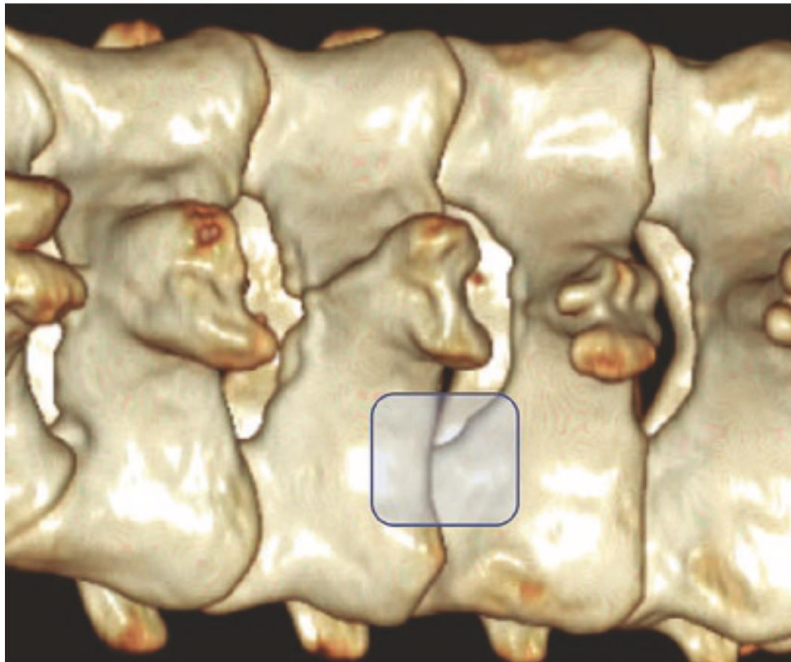




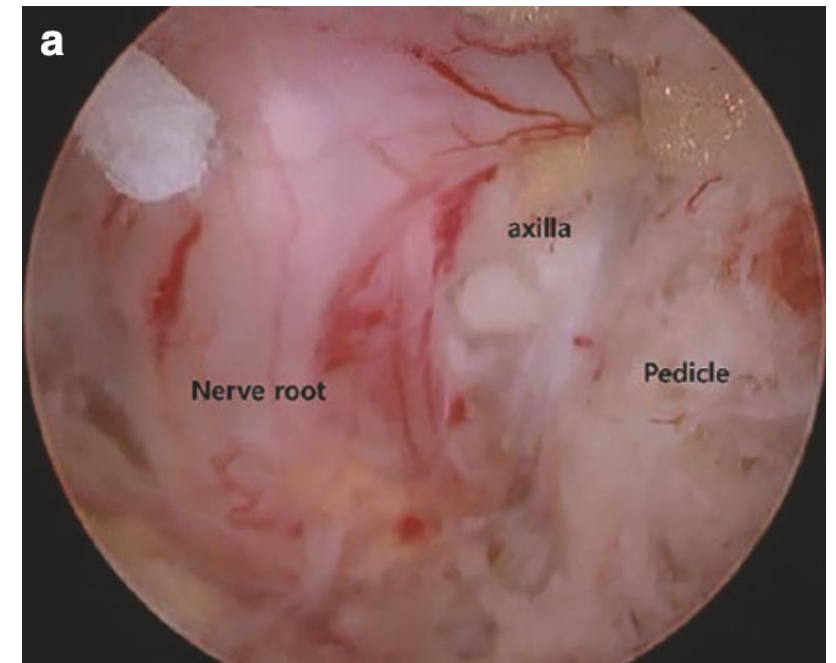
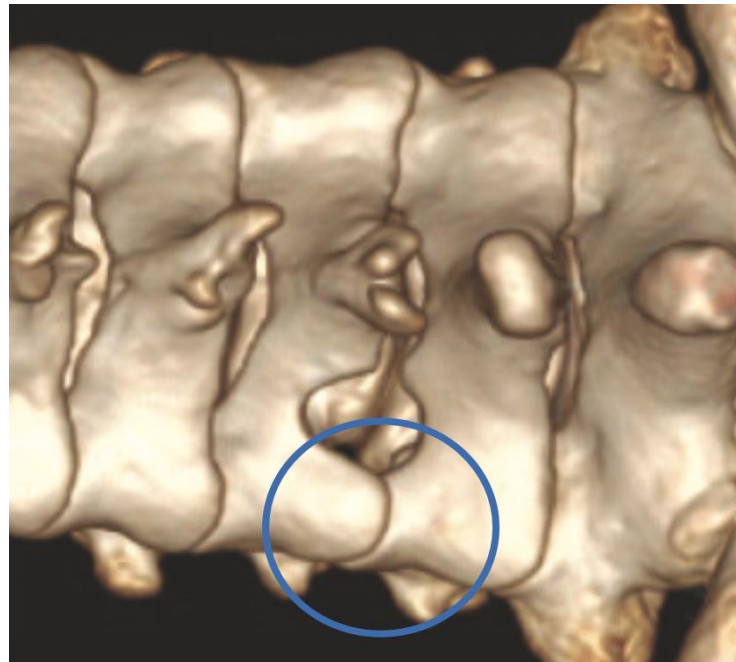
drilling SAP (Undercutting facet joint)

Cervical Techniques

- Application of UBE in C-spine surgery
 - Decompression and exposure of nerve root and dura

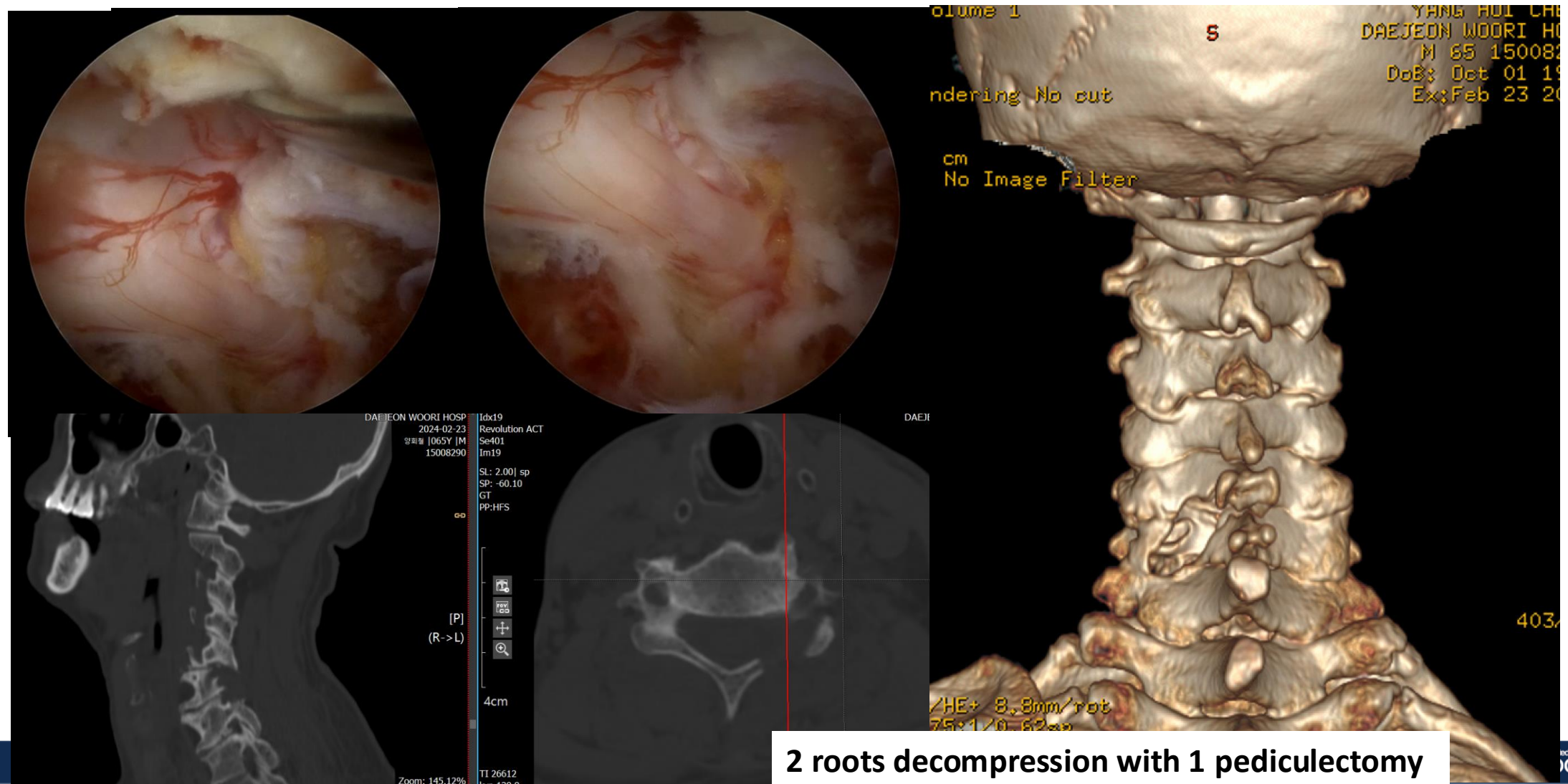


Small foraminotomy with medial facetectomy



Partial pediculectomy is useful to identify foramen & prevent bone-instrument jamming

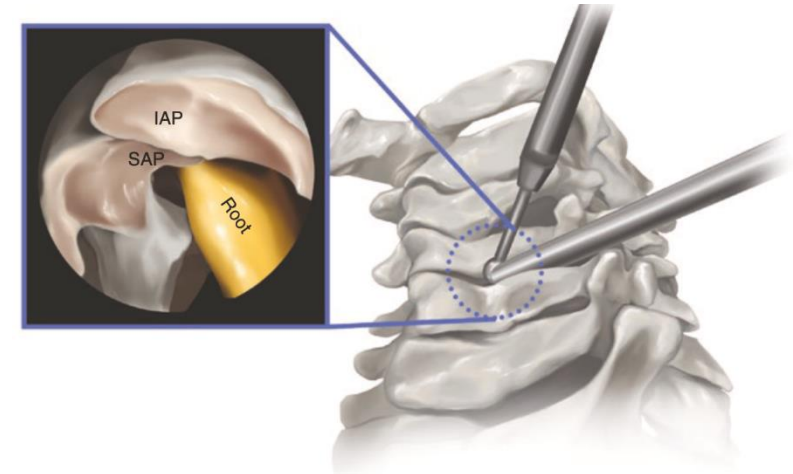
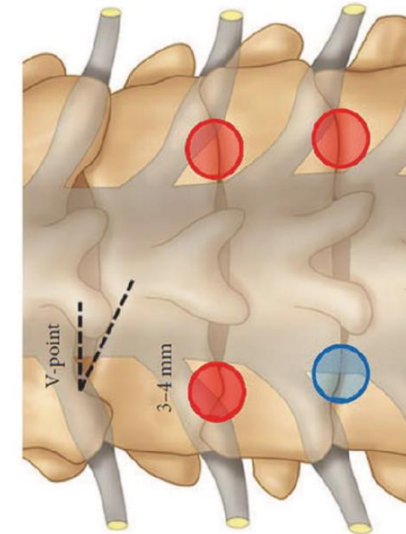
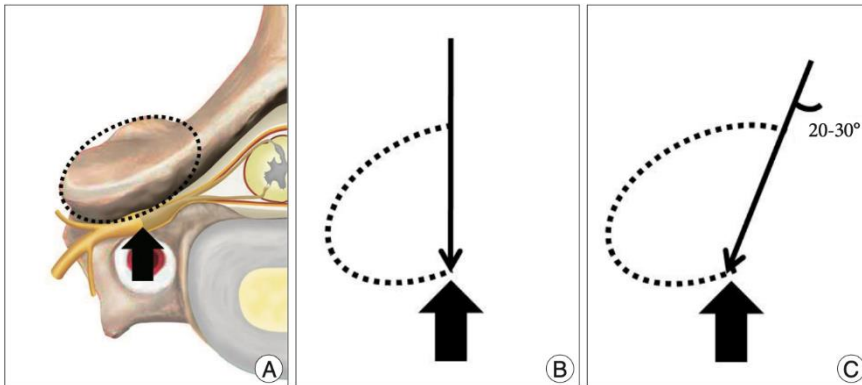
65/M with CSR LT C5-7 S/P UBE foraminotomy Lt. C5-7



Cervical Techniques

- Tip & tricks for UBE in C-Spine Surgery

- Left side standing can access both side axillary lesion for Rt Hand surgeon
- Contralateral standing
 - When inclinatory foraminotomy is needed
 - Reduce facet violation
 - Able to perform partial pediclectomy

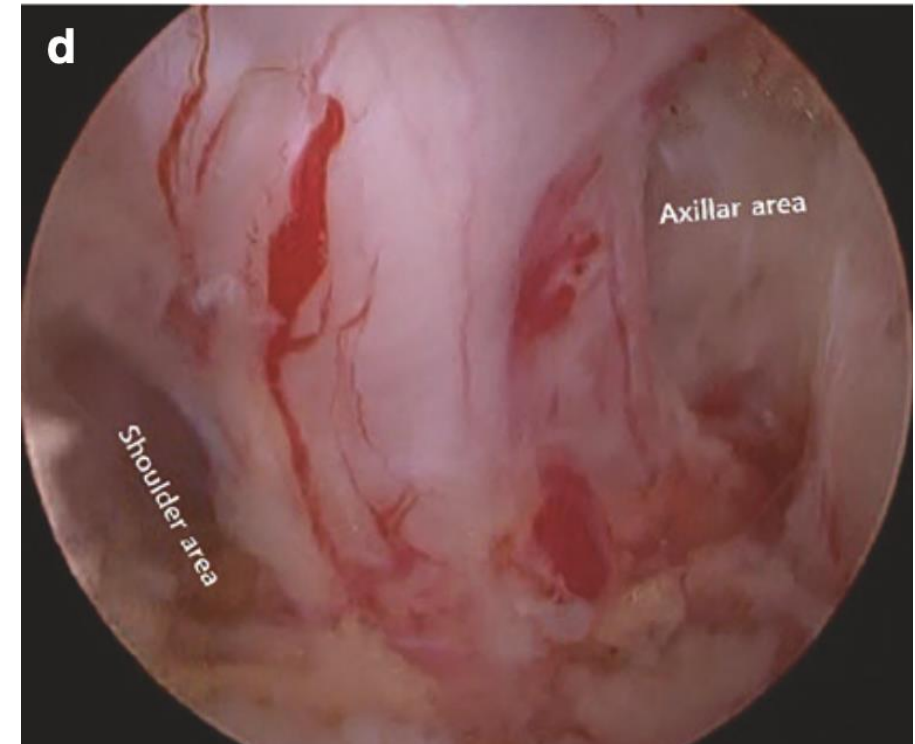
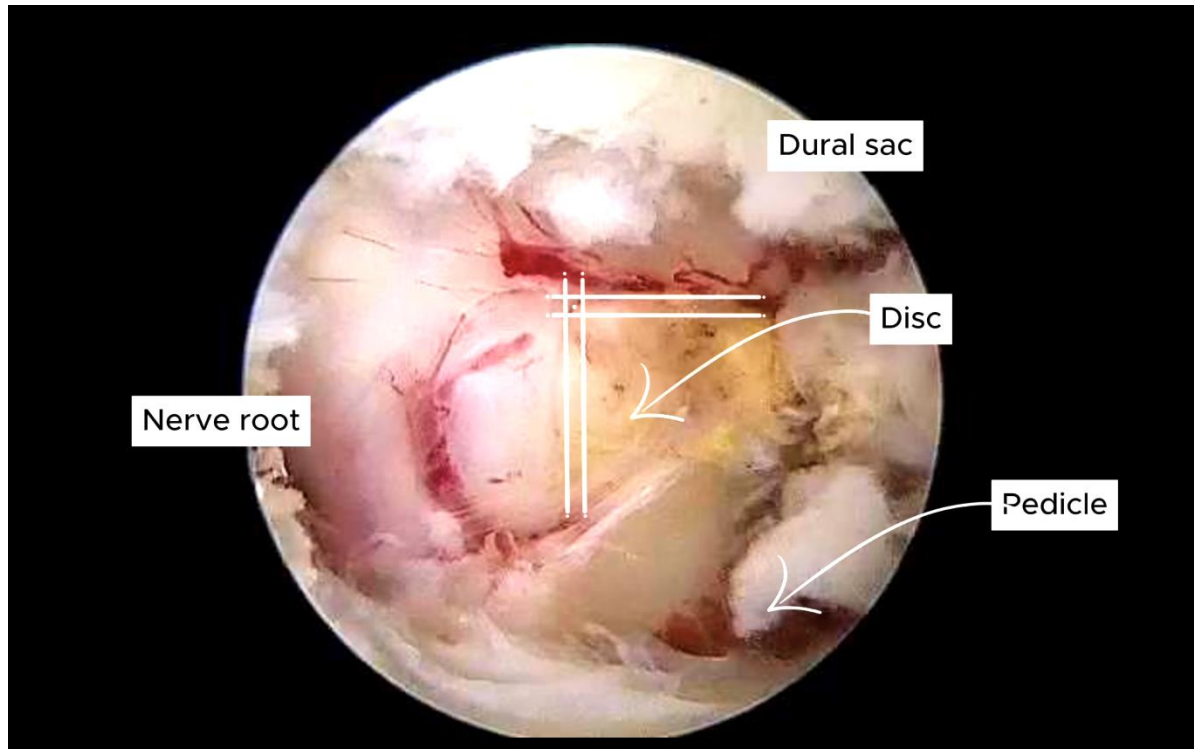


Cervical Techniques

- Tip & tricks for UBE in C-Spine Surgery

- Partial pediculectomy is useful

- Able to probe nerve root, ensure the completion of decompression
- Prevent bone and instrument jamming during biportal surgery



Thoracic Techniques

- Drilling Stage in T-spine surgery

- Identification of Midline

- Extent of Drilling

- Cranial; Origin of flavum

- Caudal : Lower laminar

- Right/left lateral : SAP

- Ligamentum flavum Removal



Thoracic Techniques

- Drilling Stage in T-spine surgery

Safe zone (Green)

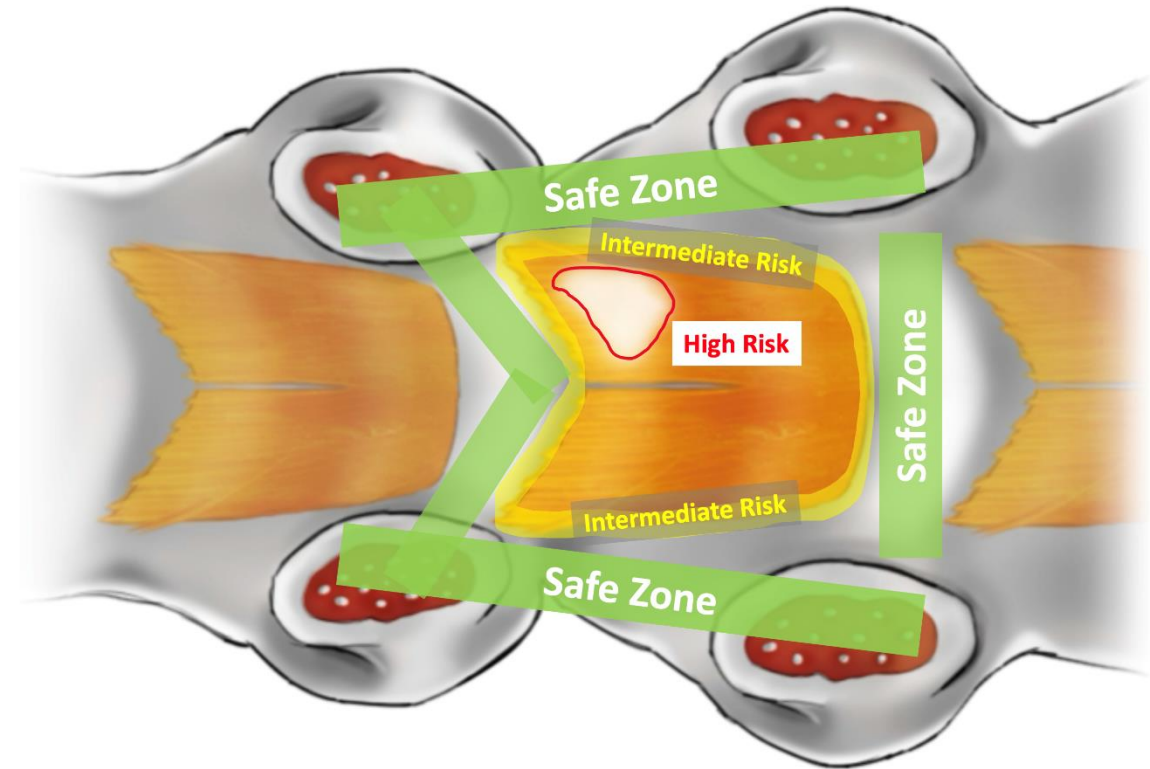
- Outside the pedicle's medial wall
- Beyond ligamentum flavum attachment

Intermediate-risk zone (Yellow)

- Normal flavum, no spinal cord compression

High-risk zone (Red)

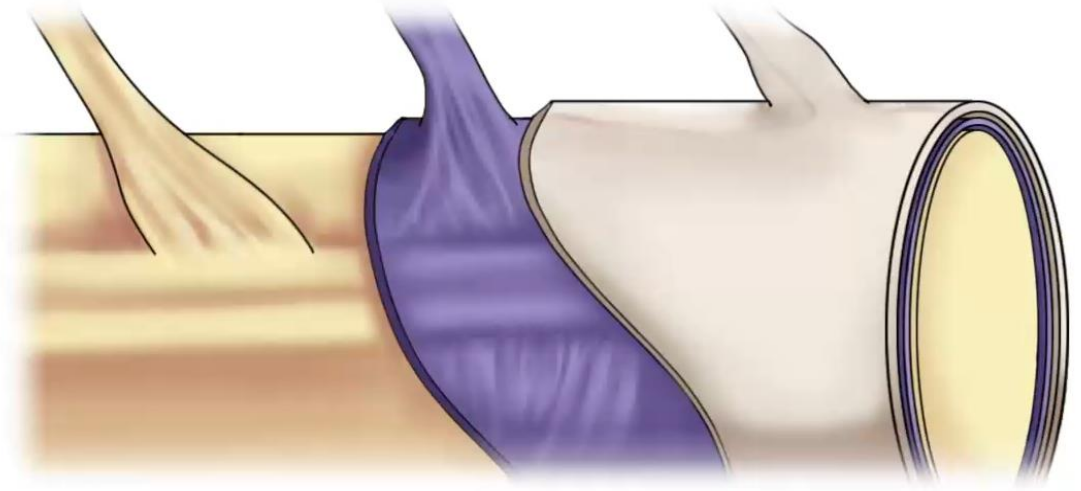
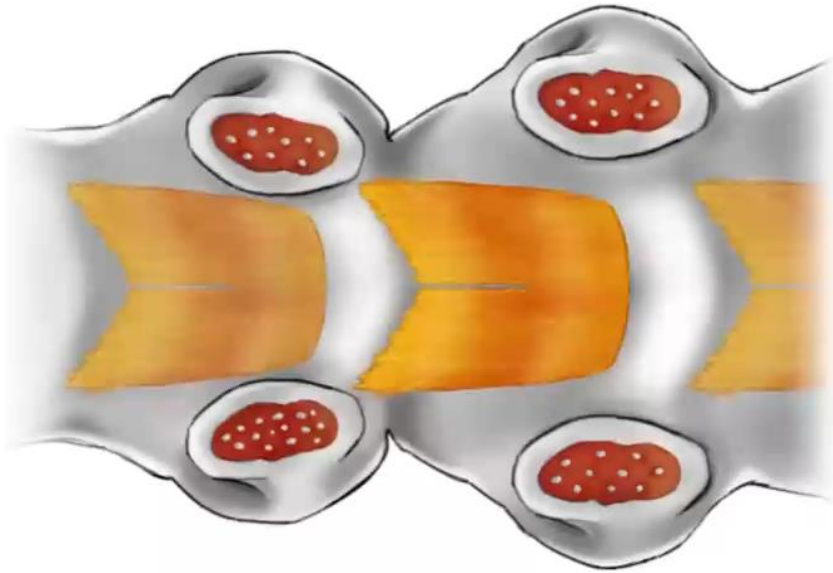
- T-OLF causing spinal cord compression



Use various type of drill tips

Thoracic Techniques

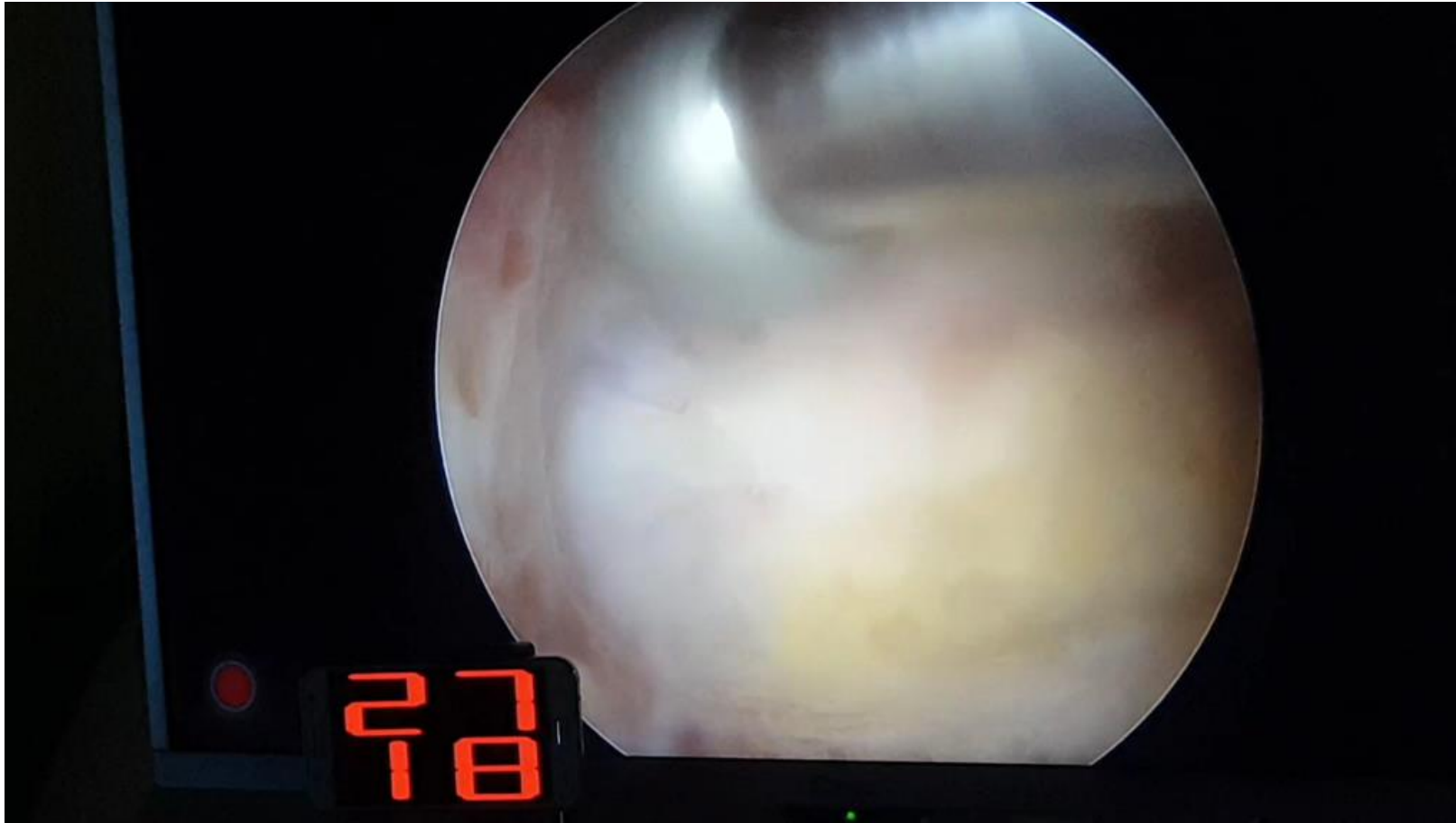
- Ligamentum Flavum Removal



- All margin of dangerous must be confirmed before T-OLF removal
- Avoid early exposure of dura
- Avoid drilling when ossified ligamentum flavum is islanded.
- Avoid using sharp tools as much as possible and instead utilize blunt tools to pull upwards

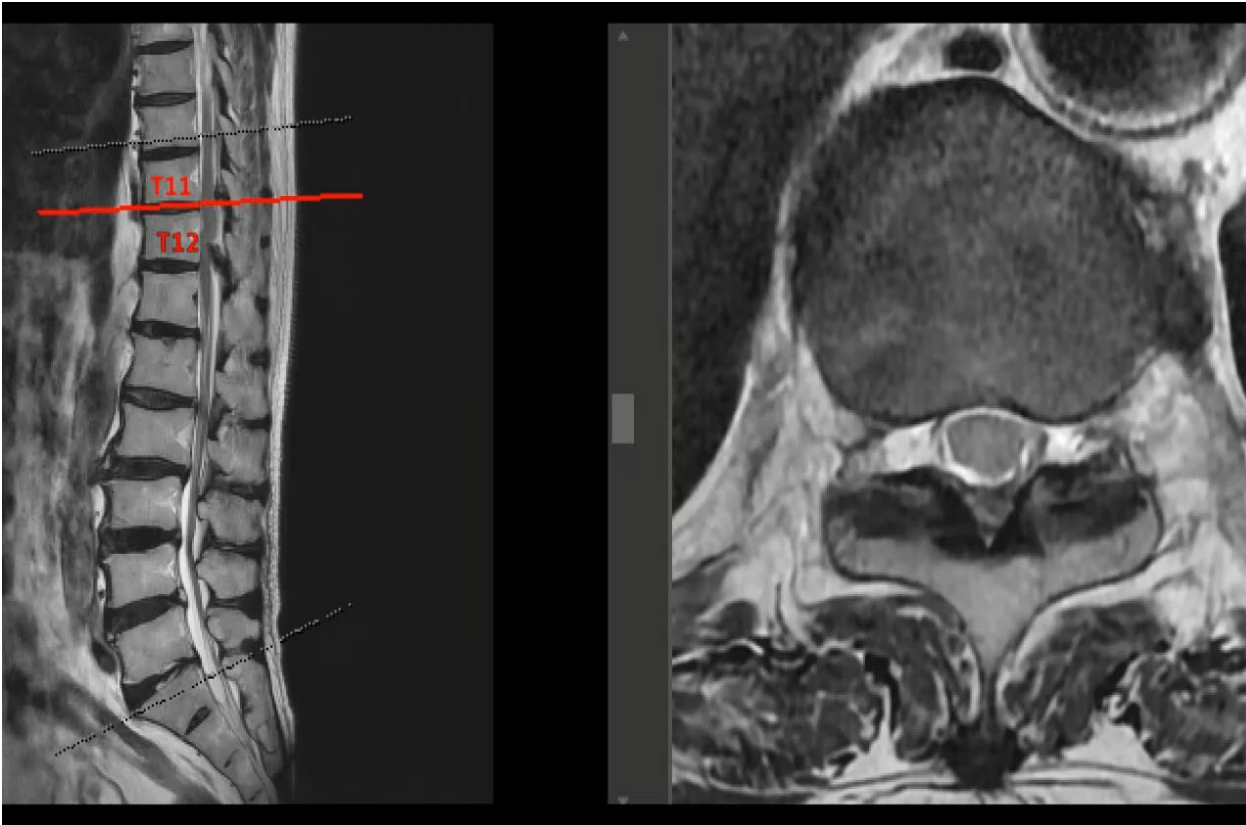
Thoracic and Cervical Techniques

- Mild case : Male / 65 OLF removal – ULBD T11-12 Rt (Lt. side standing)

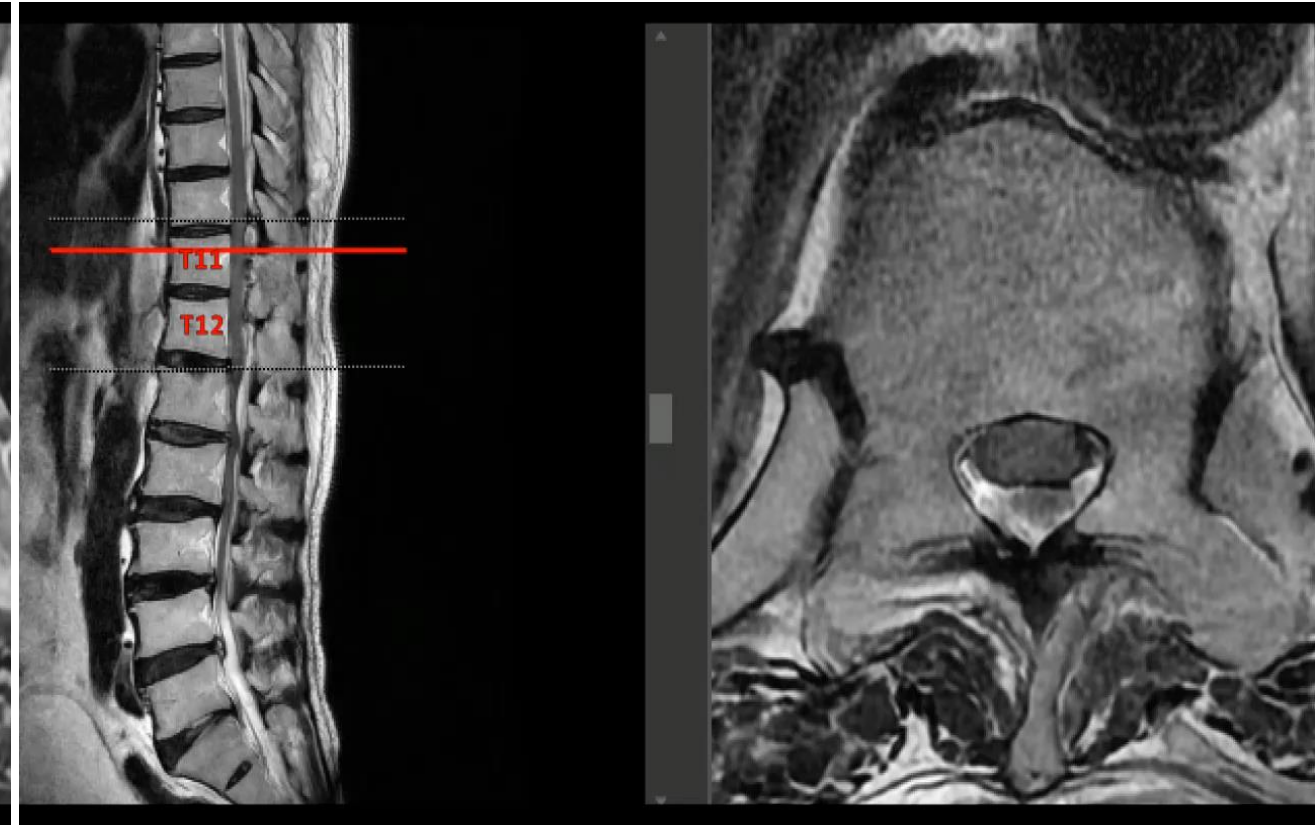


Thoracic and Cervical Techniques

- Mild case : Male / 65 OLF removal – ULBD T11-12 Rt (Lt. side standing)



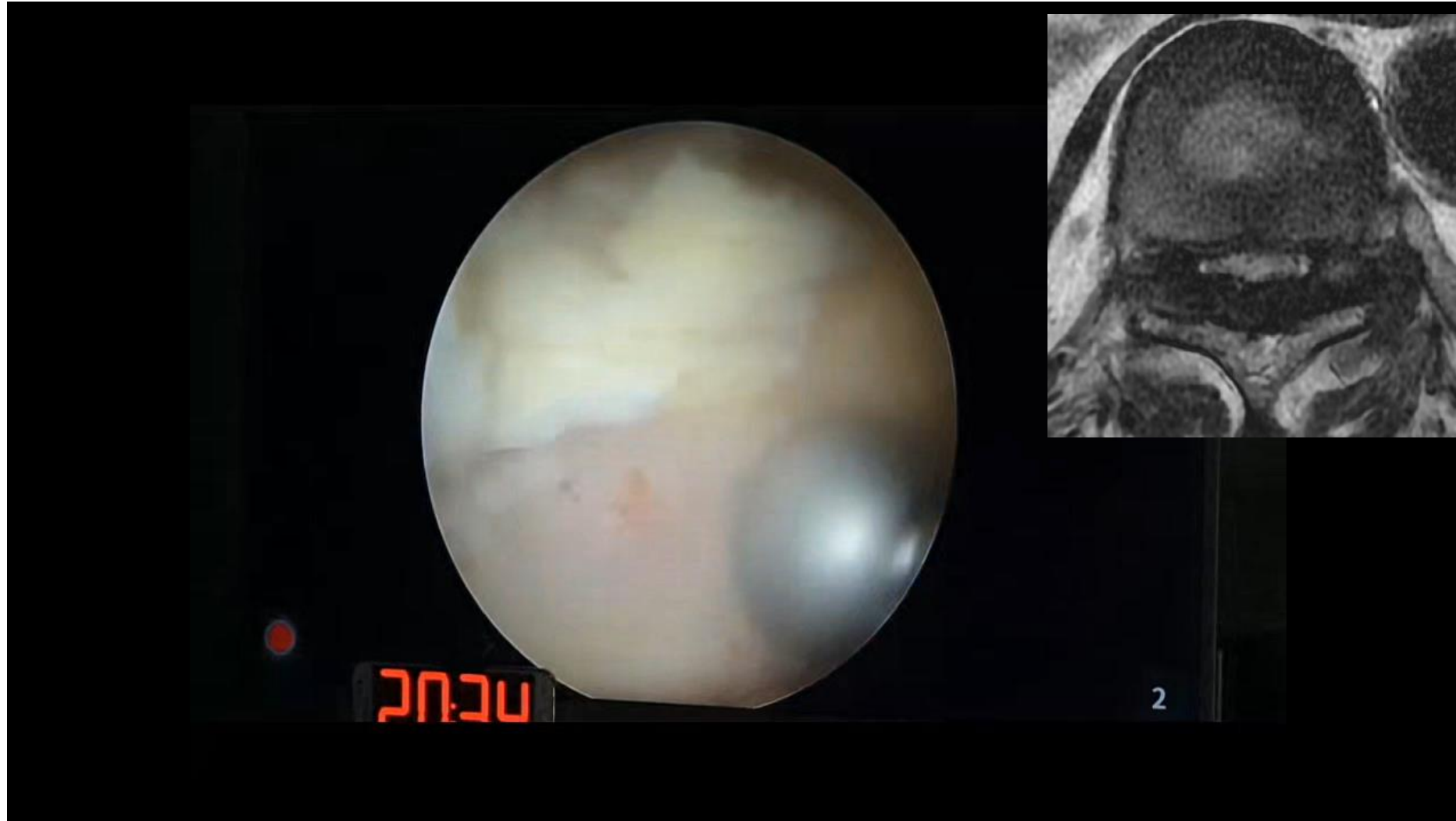
Pre-OP



Post-OP

Thoracic and Cervical Techniques

- Severe case : Male / 67 OLF removal – ULBD T10-11-12 Lt

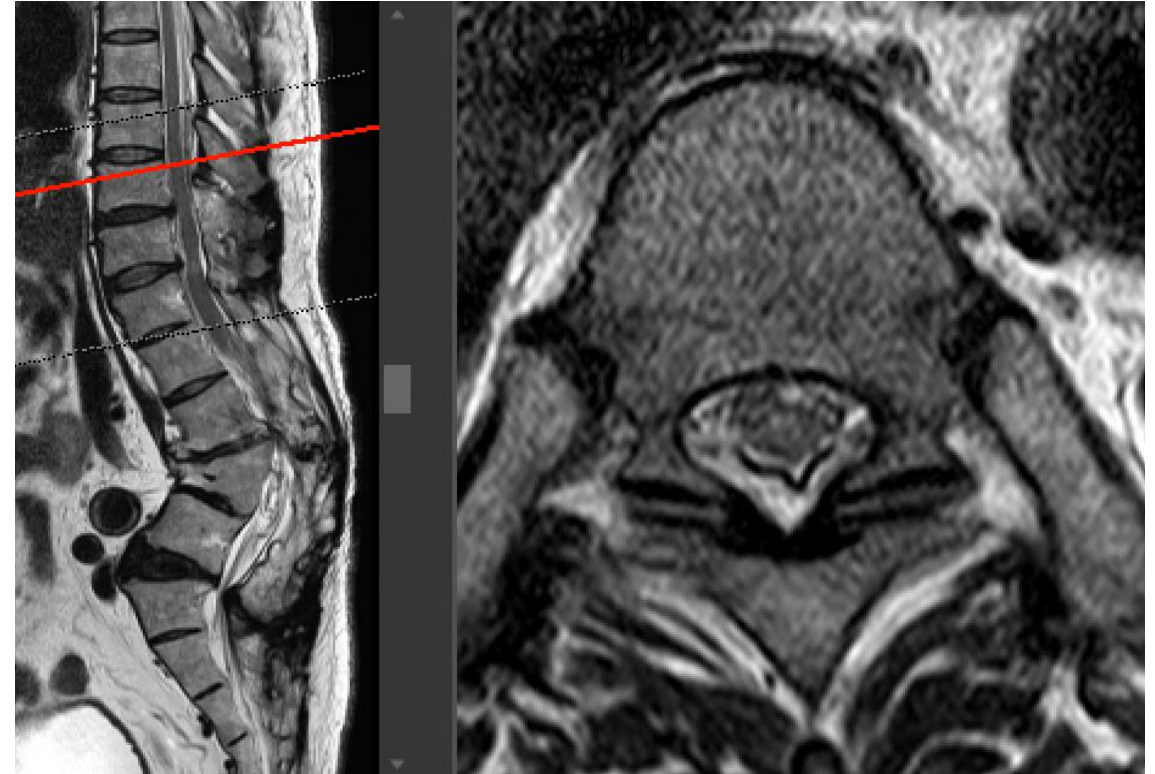


Thoracic and Cervical Techniques

- Severe case : Male / 67 OLF removal – ULBD T10-11-12 Lt



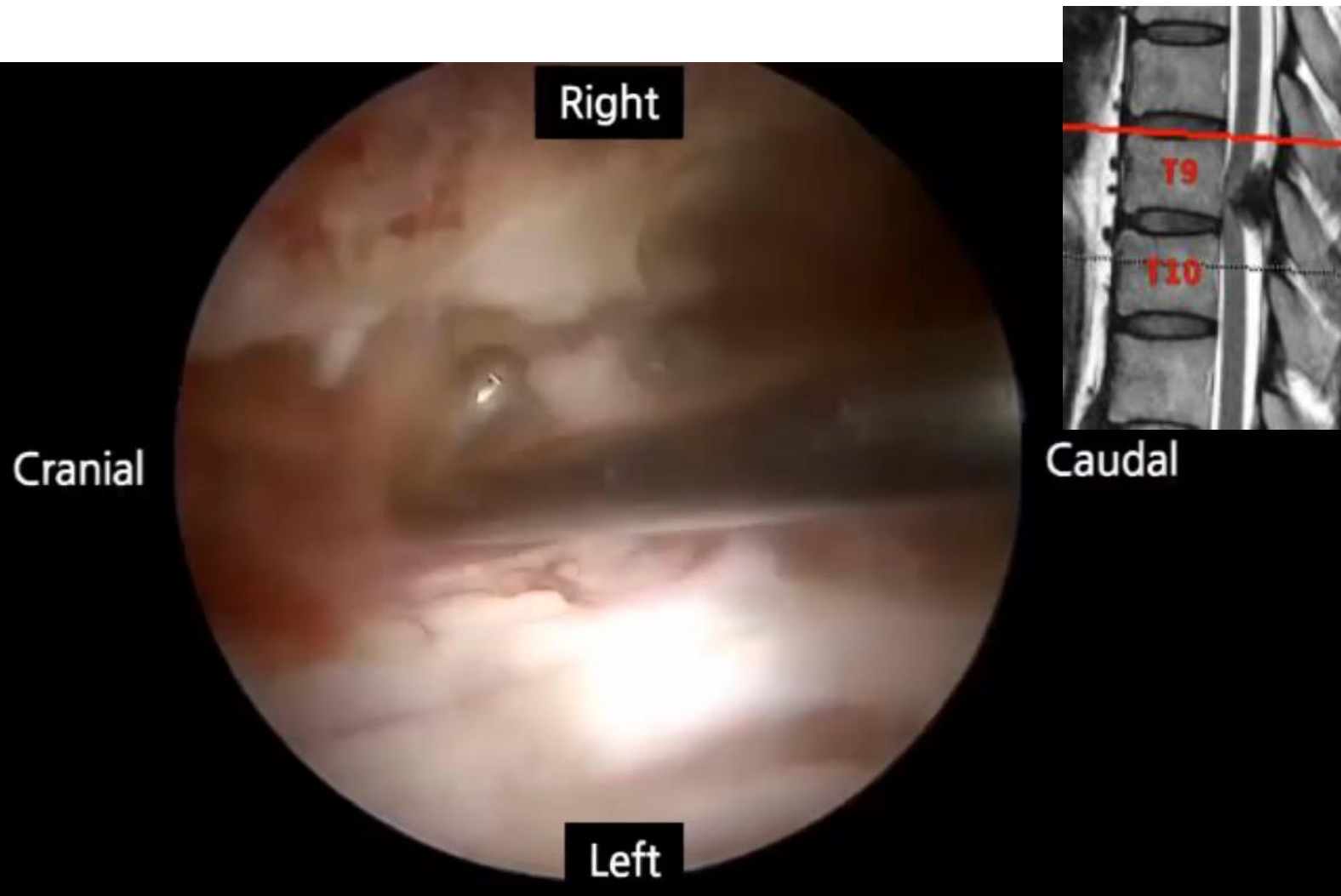
Pre-OP



Post-OP

Thoracic and Cervical Techniques

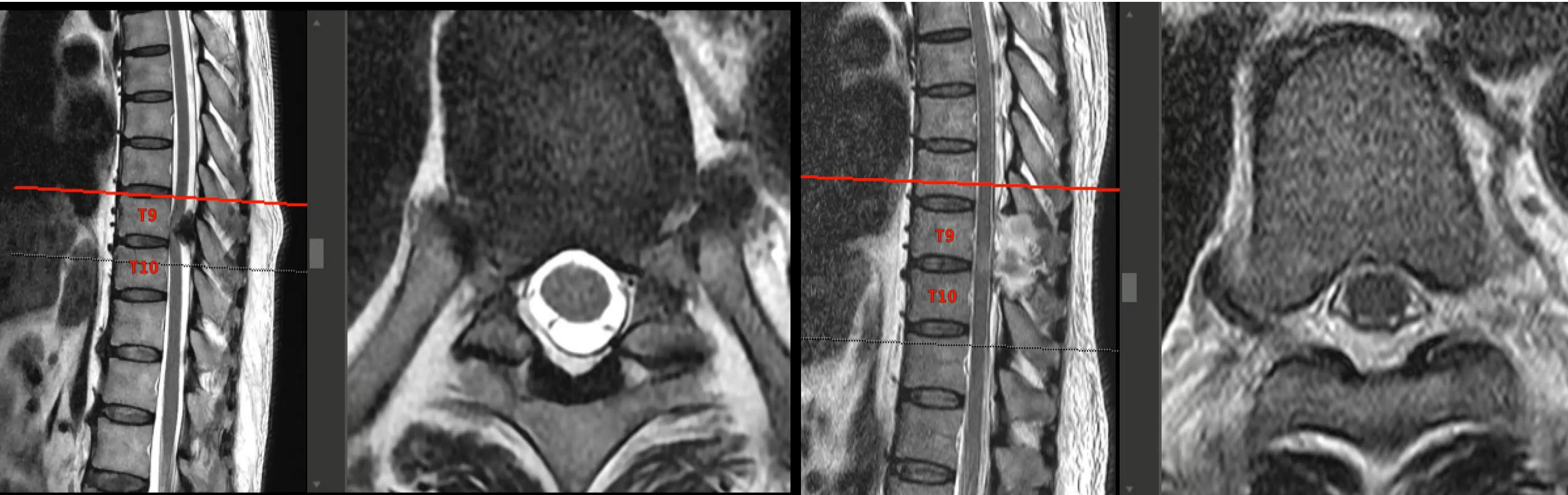
- Serious case(Arachnoid membrane preservation) : Male / 60, ULBD T9-10 Rt.



Post-OP 3DCT

Thoracic and Cervical Techniques

- Serious case(Arachnoid membrane preservation) : Male / 60, ULBD T9-10 Rt.



Pre-OP

Post-OP

Conclusion

- **Biportal Endoscopy offers a good surgical option**
 - to decompress the spinal canal with excellent visualization and instrument handling.
 - We can use every open surgical instruments and technique with better view
- **En bloc removal of the ligamentum flavum**
 - is a safe and reproducible technique as it protects the underlying dura throughout the surgery from unnecessary exposure.
- **Detailed understanding of the LF attachments**
 - Allows us for is important for easy removal and detachment
 - Finding “L and J line”, and making butterfly
 - Unlike the lumbar spine, the thoracic and cervical spine have narrow neural canals, so care must be taken when doing bone work
 - By using preoperative image to identify safety zone and dangerous zone, surgery can be performed more safely and efficiently
 - Depending on the severity of the condition and the alignment of the spine, various methods can be used for LF removal, such as piecemeal or en bloc removal.



***Thank you for
your attention***

- <https://www.facebook.com/groups/All about Endoscopic Spine Surgery>