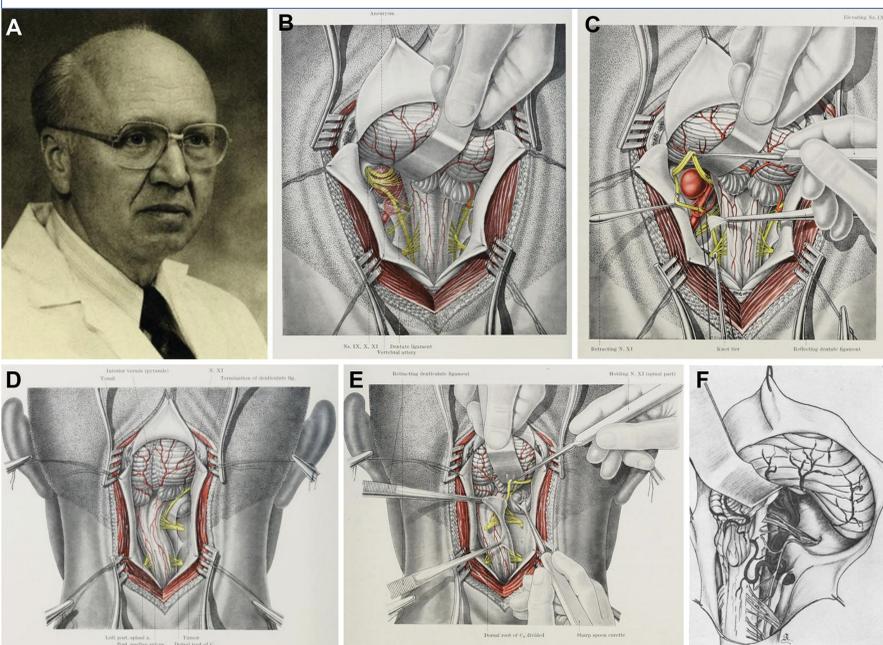


### Introduction

- Posterior fossa surgery evolved from wide suboccipital exposures in the late 19th century to refined microsurgical techniques in the 20th century.
- Despite these advances, traditional posterior approaches were inadequate for lesions of the ventral foramen magnum (FM) and anterior craniovertebral junction (CVJ).
- These regions are shielded by the clivus and upper cervical spine and contain critical neurovascular structures, often requiring substantial brainstem retraction for access.
- Ventral FM meningiomas and vertebrobasilar aneurysms → retrosigmoid craniectomy
- Alternative routes, such as the transoral approach, were associated with high morbidity, including infection and CSF leakage.
- The far lateral approach (FLA), conceptualized in 1972 by Hammon and Kempe, introduced a lateral corridor to ventral and ventrolateral FM/CVJ lesions while minimizing brainstem and neurovascular manipulation.
- Subsequent refinements expanded its indications and improved surgical safety.
- This study examines the historical development of the FLA and its variants, illustrating how neurosurgical innovation addressed a major anatomic challenge.



**Fig. 1:** Ludwig Kempe (1915-2012) (A), his early approaches (1968-1970) to vertebral artery aneurysms (B-C) and FM meningiomas (D-E), both before the development of the FLA, and his posterior fossa approach for vertebrobasilar junction aneurysms (1972) (F)

### Early Developments (1972-1986)

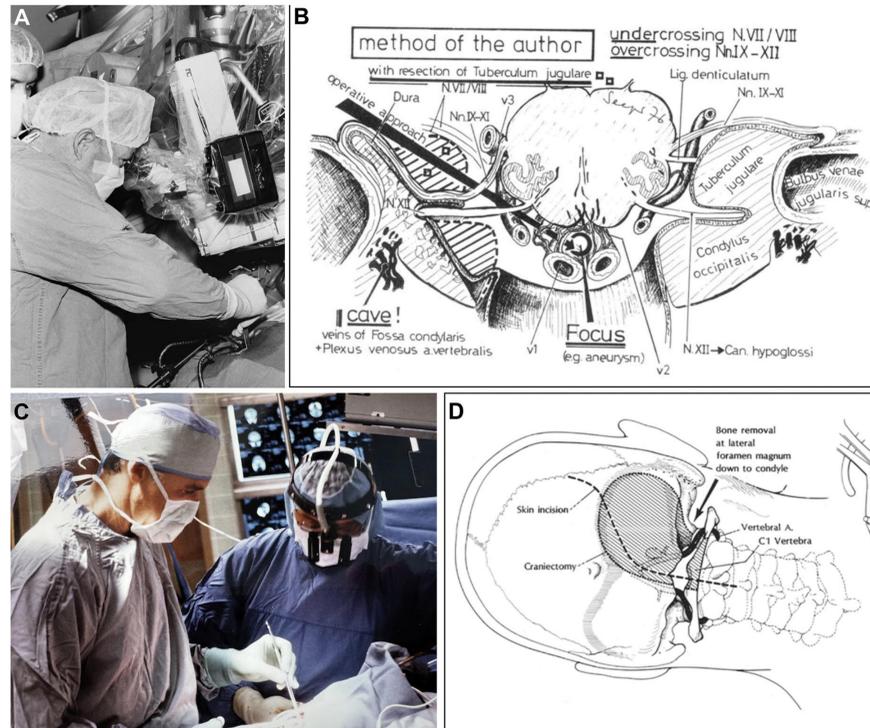
- Hammon & Kempe (1972):** First lateralized posterior fossa corridor, reducing morbidity through a more direct route to vertebrobasilar lesions.
- Seeger (1978):** Introduced jugular tubercle and condylar drilling, showing bone, not cerebellum, limits ventral exposure.
- Heros (1986):** Influenced by Drake, Heros standardized the lateral suboccipital trajectory, enabling ventral brainstem access with minimal retraction.
- Perneckzy (1986):** Emphasized dorsolateral exposure and preservation of craniovertebral stability.

### A Family of Approaches (1988-1997)

- George (1988) – Lateral Extension of the Posterior FM Approach:** Introduced VA control and lateral FM rim removal to access anterior/anterolateral FM tumors.
- Spetzler (1990) – Far Lateral Approach:** First formal use of the term; standardized partial condylectomy, C1 laminotomy, and VA mobilization.
- Sekhar & Sen (1990-1994) – Extreme Lateral Approach (ELA):** Expanded lateral skull base exposure with lesion-tailored condylectomy and defined stability-preserving limits.
- Wolfgang Seeger (1978) → Bertalanffy (1991) – Dorsolateral Suboccipital Transcondylar Approach (DSTA concept origin)**
- Crockard & Kratimenos (1993) – Stability-Preserving Lateral Variant:** Advocated minimal condylar resection to maintain AOJ stability
- George (1995) – Juxtacondylar Approach:** Targeted JF lesions with lateral bone work while often avoiding condylectomy.
- Rhoton & de Oliveira (1997) – Defined transcondylar, supracondylar, and paracondylar variants.**
- Toshio Matsushima (1996-1998) – Transcondylar Fossa Approach (TCFA):** JT removal through the condylar fossa while preserving the condyle and AOJ.

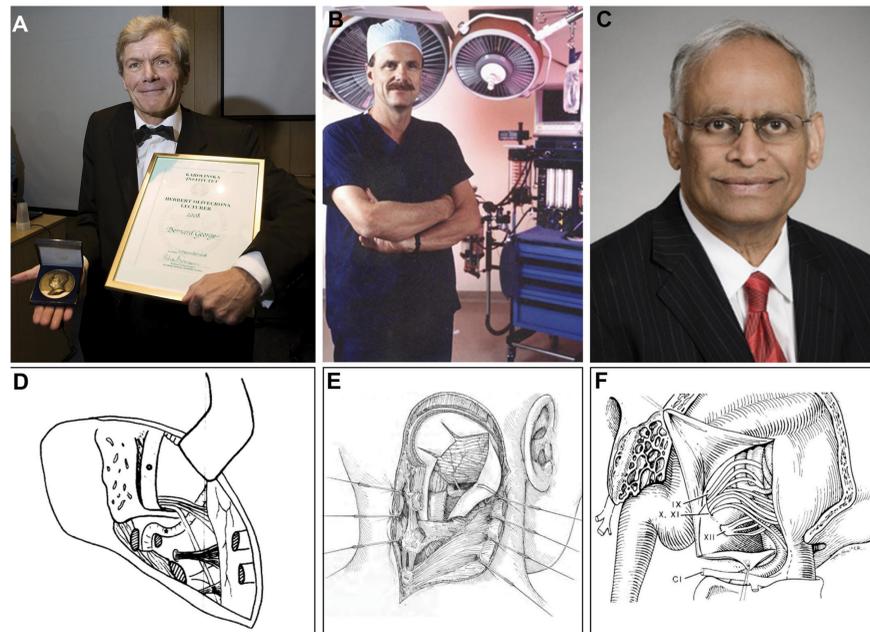
### Continuing Evolution (2000-)

- By 2000, the FLA was widely adopted with several variants developed.
- ELITE:** Infrajugular drilling of the occipital condyle and jugular tubercle for jugular foramen and ventral FM lesions.
- Limited ELITE:** FM exposure with C1 hemilaminectomy, preserving the condyle.
- MIST:** Endoscope-assisted approach avoiding condylectomy and C1 hemilaminectomy.
- Ongoing refinements and novel variants of the FLA continue to be developed.



**Fig. 2: Anatomical Foundations of FLA**

- (A) Charles Drake (1920-1998) emphasized the lack of safe operative access to basilar origin aneurysms, inspiring Roberto Heros' lateral suboccipital approach for vertebrobasilar lesions.
- (B) Wolfgang Seeger's (1929-2018) axial section showing jugular tubercle drilling to access the ventral brainstem without medullary retraction
- (C) Heros standardized the lateral suboccipital approach in 1986.
- (D) Heros' illustration of lateral FM rim removal and C1 hemilaminectomy; dashed area indicates bony resection limits and skin incision trajectory.



**Figure 3. Key contributors and technical evolution of FLA.**

- (A) Bernard George (1948-2021) introduced systematic VA mobilization in 1988
- (B) Robert Spetzler emphasized the transcondylar variant for lower clivus and upper cervical lesions and used the term for the first time "Far Lateral Approach" in 1990
- (C) Laligam Sekhar proposed the extreme lateral approach in 1990
- (D) George's (1988) lateral approach to the anterior foramen magnum
- (E) Spetzler's (1990) far lateral exposure of the inferior clivus and anterior brainstem
- (F) Sen and Sekhar's (1990) extreme lateral approach

### Conclusions

- The evolution of the FLA illustrates a clear example of operative innovation in neurosurgery. Its history reinforces the central role of anatomy in achieving safe surgical exposure.
- The FLA represents a spectrum of variants, adapted to lesion location and craniovertebral stability rather than a single standardized technique.
- Historical progress relied on developing a repertoire of flexible solutions to anatomical and physiological challenges. The evolution of these solutions provides broader insight into how neurosurgical innovation occurs.
- The FLA exemplifies the enduring neurosurgical balance between maximizing exposure and minimizing operative risk. Its refinement demonstrates how this balance can be successfully achieved through anatomical understanding and technical evolution.

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